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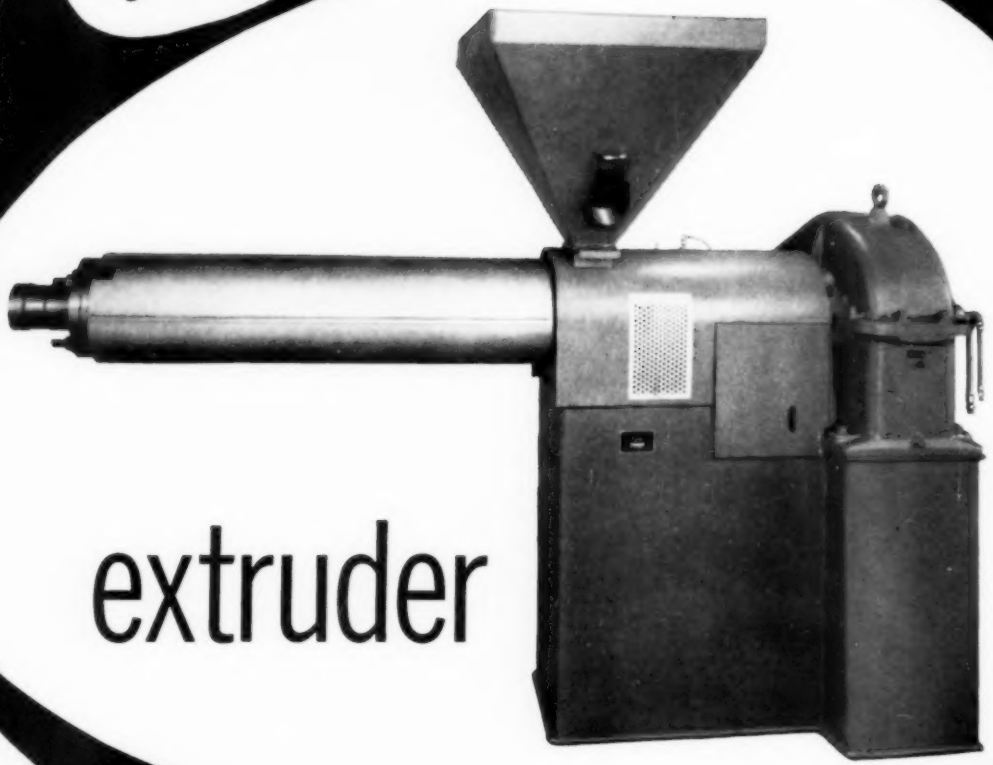

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The Society of Plastics Engineers Journal is not responsible for the views expressed by individual contributors. Copy for each issue should be received at The Security Bank Bldg., Athens, Ohio, before the 25th of the preceding month.

Across the Editor's Desk

The following very interesting letter comes from The Research Association of British Rubber Manufacturers, 105 Lansdowne Road, Croydon, England, and is here printed for two purposes. First, it is important for anyone interested in rubber; and second, we think perhaps it can help show the way for an eventual classification and collection of the plastics literature.

Dear Sir,

We found many years ago that properly to serve our Members as an Information Service on all aspects of Rubber Science and Technology it was essential to be able to classify on a systematic and logical basis all the information available.

Our system has come into wider use, and a revised System has been agreed upon by ourselves, the Rubber-Stitching in Delft, and the Institut Francais du Caoutchouc in Paris for use by all our associated Institutions in Europe and in the Far East. It is the basis of classification used in our monthly periodical "Rubber Abstracts", now in its thirty-first year.

It is proposed eventually to issue the System in printed form, and also in French and German versions, together with an Index, now in preparation, but it has occurred to us that it would be useful to invite attention to it in the pages of your journal so that interested Librarians and Rubber Technologists could submit comments and suggestions in time for them to be considered before committing the thing to print.

The Circular can be obtained free of charge on application to the Secretary here.

Yours faithfully,
L. O. Messenger
Intelligence Division.

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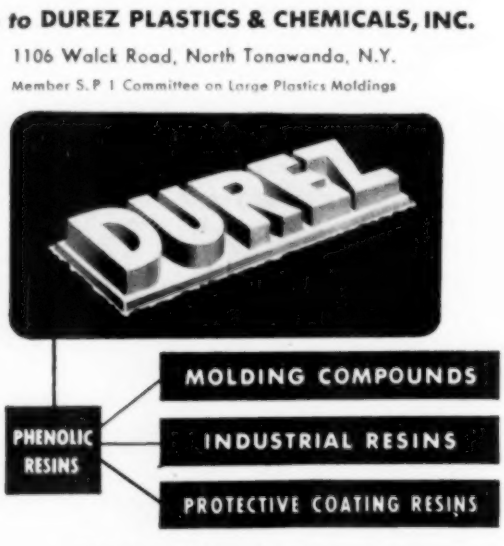

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Transfer Molding—

Preheating of Preforms

Edward W. Vaill

Edward W. Vaill

Bakelite Co., Division of Union Carbide & Carbon, Inc.

A contribution from the Professional Activities Committee, Area I, of the Society of Plastics Engineers.

Presented at the Ninth SPE Conference

IN THE PRODUCTION of molded parts using thermosetting molding materials, two basic methods may be employed. The oldest and most common method of molding is to charge the molding material directly into the heated mold cavity or cavities, close the mold, and apply pressure. The second and more modern method of molding thermosetting materials is by the closed-mold method. By this method, also referred to as plunger or transfer molding, the empty, heated mold is first closed, and the material in a hot plastic state is then forced into the cavity or cavities from a separate pressure chamber.

This second method of molding is not limited to the use of general purpose phenolic materials, but also may be used to advantage in the molding of medium and high impact phenolics, ureas, melamines and alkyd molding compounds.

The main advantages of molding by the plunger or transfer method are extremely rapid cure times, and the molding of intricate shapes which may include both thin and thick sections. Delicate metal inserts and small blind holes may be incorporated in the design of the molded part with a minimum of pin distortion and dislocation of inserts. Molded parts may be held to close dimensional tolerances by this method, since the mold is already closed at the time the material is injected into the cavity.

PREFORMS

IN MOLDING by the transfer or plunger method, the material is generally preformed. The size and shape of the preform are determined by the overall weight of the charge, the design of the transfer or plunger pot, and the particular preheating technique to be used. The preforms should be of sufficient density or hardness to prevent crumbling or cracking prior to charging the preheater. Excessively hard preforms will result in non-uniformity in the heat absorption of the preforms with a resultant non-uniformity in softness, particularly where multiple stacks of preforms are preheated by the radio frequency method.

Positioning of Preforms in Preheater

When preheating preforms by the steam preheat method, it is advisable to arrange the preforms in a single layer on the preheating tray, so that the preforms may absorb the greatest amount of heat and in certain cases, moisture in the shortest length of time. Preforms should be of minimum thickness consistent with economy, depending upon the number of preforms used for each mold charge.

In preheating by the infra-red or dry oven method, the same principle applies. However, in the case of infra-red preheating, unless both top and bottom lamps are employed, preforms should be turned over half way through the preheating cycle in order that the preforms will be of uniform temperature on both sides.

Positioning of Preforms for Radio Frequency Preheating

Since the heating time for preforms by this method requires only a matter of seconds, it is extremely important that the stack of preforms on the bottom electrode be arranged carefully and uniformly. If one part of the preform charge is insufficiently heated, these preforms will retard the plastic flow of the total charge in the molding operation and will result in low density moldings and shorts. If the other part of the preheated charge is overpreheated, the result will be burned streaks in the molded part, pimples, low density moldings, and shorts due to the setting up of the material before the cavities are completely filled.

When plunger or transfer molding is done with more bulky materials such as those containing cotton flock or long fibered asbestos fillers, it is recommended that a rectangular preform be used, since there is the possibility of variations in the thickness and density of the preforms. When preforms of varying thicknesses are stacked one upon the other in multiple stacks, the air gap between the top of the preform and the top electrode will vary. The stack with the smallest air gap will heat up more rapidly and to a greater extent than the stack with the greatest air gap. On the other hand, if the rectangular preforms are stacked on their sides, where the dimension is usually constant, thickness and density variations as affected by the radio frequency oscillation is held to a minimum, since the air gap will be more constant.

Preheating Equipment

In preheating thermosetting molding materials for the production of molded parts by the plunger or transfer method, there are three main types of heating: Radio Frequency; Steam Oven; Infra-red.

Since the radio frequency is the most popular, we will discuss this first. Great strides have been made in the design and efficiency of radio frequency preheaters since this method was first announced by Bakelite Company in 1943.

With the continued improvements in the efficiency of the commercial radio frequency preheaters being made, the radio frequency oscillations have been increased. Early preheaters operated in the range of 10 to 30 megacycles. However, one major producer of radio frequency preheaters is now building units to operate in the 60 to 70 megacycle band.

According to an investigation made by V. E. Meharg and A. Mazzucchelli of Bakelite Company, loss factor of material does not vary appreciably with frequency. However, arcing and flashovers caused by excessive voltage at the electrodes present a serious difficulty and limit the rate of heating when too low frequencies are used. This is especially true when desiring to heat a material having good electrical properties.

The higher frequency ranges in the 60 to 70 megacycle band, according to one major radio frequency preheater manufacturer, produce greater efficiency of the preheater and a more uniform temperature within a preheating charge.

Radio frequency preheating machine electrodes may either be round, rectangular, or square. Sharp corners should be avoided, and the electrodes should be kept clean and highly polished at all times.

Since electrodes tend to accumulate a residue film from the preforms as they heat and emit moisture, it is advisable to periodically clean them with either acetone or carbon tetrachloride. Since the average press operator will pay little attention to the condition of the electrodes, it has become rather general practice to lay a piece of thin cardboard on the electrode and stack the preforms on it. Another piece of cardboard should be placed on top of the preforms. When the cardboards become dirty, they are discarded by the operator and replaced by clean ones.

AIR GAP

Good radio frequency preheating practice requires an air gap of at least $\frac{1}{8}$ inch and preferably $\frac{1}{4}$ inch between the top of the stack of preforms and the top electrode. This allows for more rapid escape of volatiles in the material as it heats and the elimination of moisture condensation on the top electrode which is not subsequently absorbed back into the preforms. An air gap allows for the swelling of the preforms as they heat and also reduces the tendency for the material to arc, which will result in the shutting off of the machine.

In many cases, particularly where asbestos filled materials or materials containing graphite are preheated by radio frequency, it is necessary to use a Pyrex plate or glass fibre spacer plate under the stack of preforms. This plate acts as a loading tray for charging the preforms into the preheater. Its main purpose, however, is to more evenly space the preforms between the two electrodes. This results in a more uniform preheat of the top and bottom preforms of the stacks.

It is recognized that by the use of insulation spacer plates and air gaps, that the radio frequency preheat times are slightly longer than where the technique of positive contact between preform and electrode is maintained. The greater uniformity of the preheat of the material, however, and the resultant lower rejection rate of molded parts more than compensates for the slightly longer preheat time.

The moisture content of the molding material to be preheated by radio frequency has a considerable effect upon the rate of heat developed by the high frequency oscillation. Materials which have been allowed to absorb moisture under high humidity conditions may require oven drying for 30 minutes at 190 deg. F. immediately prior to radio frequency preheating. Excessive moisture content in rapid preheating cycles may cause the burning of the material in the center of the preforms or stack of preforms, before the material on the outside and the top and bottom becomes soft. Such a condition will materially reduce the plastic flow of the material at the time it is molded and result in burned streaks, low density and porous moldings.

Circular preforms ranging in diameter from 1 inch to 4 inches are generally used particularly for those materials of the general purpose low bulk factor types, where thickness may be held quite closely. Circular preforms are somewhat easier to handle and have less tendency to chip or crumble. Round preforms are, in general, more easily charged into the plunger well of the mold since these are normally of circular design.

TIME CYCLES

Practically every radio frequency preheater is equipped with an interval timer which automatically shuts the machine off at a pre-set time. In determining the proper preheat time for any given type of material and weight of charge, it is necessary to take the following steps:

1. Arrange the preforms on the bottom electrode in accordance with standard practice as previously described.
2. Set timer to maximum time. Start preheater and at the same moment, start a standard stop-watch.
3. While the material is heating, observe the increase in milli-amp output on the milli-amp meter.
4. At the same time, observe the preforms for swelling and edge cracking.
5. If the milli-amp needle exceeds the safe operating limit as indicated on the dial, the machine will automatically shut off.
6. If (5) occurs, it is then necessary to raise the top electrode increasing the air gap.
7. With a fresh charge of preforms, repeat procedure until the preforms begin to swell, edge crack and slightly smoke.
8. Note the seconds elapsed on stop-watch and set preheat timer slightly less than the stop-watch reading.
9. Make sure that the milli-amp reading is well within the normal operating range of the machine, since this will improve the efficiency of the machine and lengthen the life of the tube.

Once a satisfactory time cycle is established, slight variations to obtain hotter or cooler preforms may be made by raising or lowering the top electrode. This method is generally more accurate than varying the time setting on the timer.

When difficulties are encountered in getting a uniform preheat of multiple stacks of preforms, it is very important that the operator check the alignment of the top electrode with the bottom electrode. The two electrodes MUST be parallel. This can be determined most readily by observing the degree of air gap from one side of the stack of preforms to the other. When the top electrode is found to be cocked, it should be immediately corrected.

Non-uniform air gap due to a cocked top electrode is

one of the greatest causes of non-uniform preheating in multiple stacks of preforms and will result in lack of plastic flow with the resultant low density or porous molded parts.

STEAM OVEN PREHEATING

Steam oven preheating has been used as a standard preheating technique by many companies in the plastics industry since 1947. The first paper on this subject was presented before the 1948 Annual Technical Meeting of the S.P.E. by S. K. Moxness and Jerome Formo as a result of their development work in the Plastics Division of Minneapolis-Honeywell Regulator Company. (*Preheating with Steam*, S. K. Moxness, SPE News, Vol. 4, No. 1, January 1948).

One of the main advantages of preheating by the steam method is that the basic equipment is relatively inexpensive and may even be built in the shop of the plastics molder.

Basically, steam is developed in a closed container which is maintained at a temperature of approximately 230 deg. F. to 270 deg. F. by electric heaters. Preforms are placed in this oven on trays in such a manner that as much area as possible of each preform may be exposed to the moist hot air. The presence of steam within the preheating oven is more effective in producing a rapid preheat of the preforms than dry oven preheat because additional heat is released by the steam as it condenses on the cold preforms.

During the first part of the preheat cycle, the preforms pick up additional moisture from the oven. As the preforms become hotter, moisture is again given off with the result that the per cent moisture content of the preform when soft and hot is somewhat lower than that of the normal moisture content of the preform prior to charging in the oven.

According to data developed by A. J. Guzzetti of Bakelite Company in September 1951, a preform of BM-120 1½ inches in diameter and weighing 37 grams was preheated in a steam oven at 230 deg. F. During the first five minutes, it absorbed .25 per cent moisture. At 15 minutes, it was at equilibrium, and at 20 minutes, it had lost .25 per cent in weight. The loss of weight from there up to 60 minutes was a gradual curve up to 1.4 per cent. This loss in weight due to loss of moisture is not nearly as great as in dry oven preheating, which showed a loss of weight at 230 deg. F. of 2.6 per cent in 60 minutes. Therefore, the residual moisture content of the material when heated by the steam preheat method may cause higher mold shrinkage and poorer electrical properties of the molded part.

The normal practice as reported by S. K. Moxness and Jerome Formo in their article, "New Developments of Steam Preheating," which appeared in the May 1948 issue of "Modern Plastics," is to proportion the number of drops of water per minute which are released in the oven, and which are vaporized by coming in contact with the heated base of the oven. The number of drops released per minute controls the rate of preheat of the preforms and the ultimate per cent moisture in the preforms when charged into the mold. Therefore, close control of the per cent moisture in the preform should be maintained if finished property dimensions and electrical properties are critical in the molded part.

The number of drops of water per minute will vary between 10 and 50 drops depending upon the size of the oven, the number of preforms being preheated, and the per cent moisture content desired in the preforms. It is very important that preforms should not be more than 1 inch thick, since greater thickness than this will require too long a time for proper absorption of moisture by the preforms and may result in non-uniform moisture content.

In general, it may be said that preheating thermosetting materials by the steam preheat method is practical and economical for the average plunger or transfer molded part which does not require close control. However, many intricately molded parts have been produced by this method and held to close dimensions by proper design of the runners and gates, so as to obtain maximum plunger pressure on the material after it has entered the cavity or cavities of the mold.

DRY OVEN PREHEATING

Dry oven preheating of preforms for plunger or transfer molding is not normally recommended due to the fact that the poor heat transfer properties of the material results in a long preheat cycle. This cycle tends to dry out the preforms and reduces the plastic flow characteristics of the material. The main advantage of dry oven preheating is in compression molding. It is used to drive excessive moisture from the material, in order that molded parts so produced shall have better electrical properties, lower mold shrinkage, and less tendency to distort or warp upon cooling.

Under certain conditions of high humidity and with the more hydroscopic molding compounds, such as cotton flock filled materials, it may be advisable to pre-dry the preforms when the parts are to be produced by the transfer or plunger molding methods. This should be done in an oven for 15 to 20 minutes at 190 deg. F. immediately prior to radio frequency preheating of the material.

This pre-dry operation will make the material more critical in its radio frequency preheating characteristics because of its lower moisture content. Molded parts so produced will have improved electrical properties and greater dimensional stability.

The main disadvantage of dry oven preheating for plunger or transfer molding is that it is extremely difficult to preheat large preforms without having excessive heat on the outside of the preforms which may result in precure, while the inside of the preforms is still cold. This results in non-uniformity of plastic flow and the possibility of low density moldings. If this type of preheating is used, it is necessary to have the oven temperature ranging between 195 deg. F. and 230 deg. F. The preforms should be as thin as possible and spaced individually in order that they will receive the maximum amount of heat in the shortest length of time.

INFRA-RED PREHEATING

Infra-red preheating, like dry oven preheating, heats the preform from the outside in and is dependent upon the heat conductivity characteristics of the material being preheated. Care should be taken that the infra-red lamps are spaced a sufficient distance from the surface of the preforms to eliminate hot spots as a result of direct heat radiation from the filament, rather than the reflected heat radiation from the base of the bulb. If preheating is done by a bank of lamps over the preforms which are heated from one side only, the preforms must be turned over half way through the preheat cycle in order that the material may be uniformly preheated throughout.

The disadvantages of preheating with infra-red lamps for plunger or transfer molding are the same as those for dry oven preheat. The advantages of pre-drying the preforms by the infra-red method prior to radio frequency preheating are similar to those for dry oven preheating.

The most efficient manner in which to preheat preforms by the infra-red method is to have a bank of lamps both under and over the preforms which should be resting on ⅛-inch wire screen. However, care should be taken to

(Please turn to page 42)

Edward Borro

Closed Mold Molding

Edward Borro

Durez Plastics & Chemicals Co.

Presented at the Ninth SPE Conference

SUCCESSFUL RESULTS in closed mold molding can only be obtained by a complete study of the elements involved. These are: Practical part design for this method of molding: Selection of the right material, because the various types of material react differently in flowing through the runners and gates; Mold design; The size of runners and gates; Position of gates; Transfer and clamping pressures.

Part design must be considered very carefully before the method of molding is selected. Very often compression molding would be advantageous, if the molded part requirements were thoroughly investigated. We shall subsequently discuss many of these requirements.

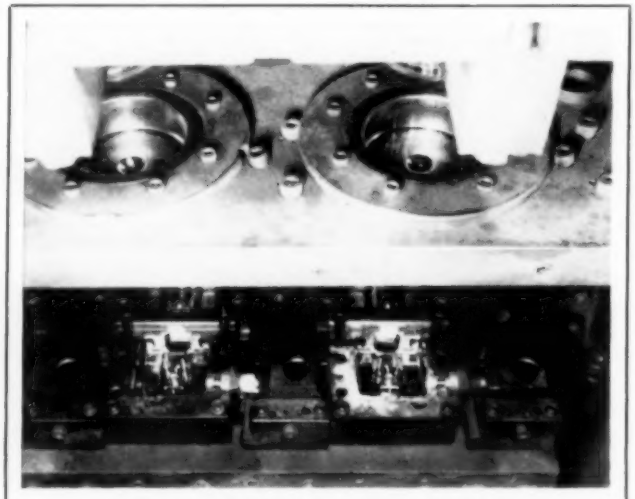


Figure 1. Pot-type or three plate mold.

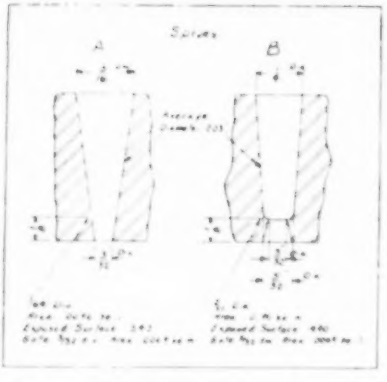


Figure 2. Two types of sprue designs.

Selection of the material is important because different types of material react differently under heat and pressure. For example, general-purpose, wood-flour-filled, two-step resin materials are of a longer flow duration than the one-step resin types. The mineral-filled materials are more heat sensitive. The sensitive materials usually require less preheat and higher molding pressures because the life or fluidity within the mold is shorter. Some of these differences in sensitivity of material are not too important in compression molding, provided there is sufficient molding pressure and reasonably fast-closing press travel. However, in the closed mold method of molding, the slightest difference in molding pressure will present difficulties in filling the cavities; in shrinkage of the part; in warpage, and often in the physical properties. The material to be used is, in most instances, the deciding factor in selecting the type and design of the closed mold.

Mold design is generally controlled by the part design. The "pot type" commonly referred to as a three-plate mold (Figure 1) is generally used when the material charge is introduced through the sprue directly into the part or over the core pin, often called diaphragm gating. This direct sprue method is generally operated at the same pressures as the plunger principle. On the particular camera front, 7,000 psi is being used for soft (general-purpose) material. The sprue dimensions are as follows: 3/16" small end, 7/16" large end, $2\frac{1}{2}$" long. When the sprue feeds the material into the runners and gates, 50% higher pressures should be considered. We have investigated the reaction of different sprues which are used in pot-type transfer molding. Illustrated in Figure 2 are two types of sprues. Sprue A is tapered from 5/16" to 3/32" dia. on the gate end. Sprue B is tapered from $\frac{1}{4}$" to 5/32" dia. at $\frac{1}{8}$" from the bottom. A reduced gate of 3/32" dia. was started at this point and tapered out to 5/32" dia. In sprue B we created the tubular insulation theory. However, our experiments proved that there is no advantage. Both tests results are about equal.

The flow time results for 149 grams of material at various pressures were as follows:

	A	B
5,000 psi	29 sec.	30 sec.
6,000	16	18
7,000	11	15
8,000	7	10
9,000	5	8
10,000	3	5

Technique . . .

The multiple six-cavity design is very practical. However, three important points must be considered in the mold design: (1) ample air venting must be provided so that the cavities will fill freely without pause of flow, (2) complete or 100% sealing grooves cannot be used—partial sealing grooves are recommended so that the material can escape and equalize the charges in the pots, thus filling all cavities, and (3) reasonably close material charge must be maintained in each pot.

The duplex ram plunger molding method (figure 3) is the most popular throughout the industry. It is, therefore, often taken for granted and designed without thorough consideration of each particular phase of operation. This results in production problems. Complete study of each phase is essential; (1) the part to be molded should be checked carefully for cross-sectional areas to determine the runner and gate size, (2) location of gate, (3) required molding pressures and (4) the location of air vents, particularly when the part has high projections such as the towers on a distributor cap. In this case, the core pins should be activated to insure escapement of air. In cases of blind bosses, ejector pins with slight flats should be located at these points for rapid venting; flats on pins are practically self-cleaning each shot. The surrounding area ¼" beyond the cavities, runners, and material chamber (figure 4) should be relieved for at least 1/16" depth to maintain a clean mold surface and prevent enlargement of the molding area in case of material leakage.

Multiple plungers are successfully employed in this method of molding. However, best results are obtained from individual cylinders operating independently from separate hydraulic lines. Multiple plungers mounted on bars or plates and operated by one cylinder cause considerable trouble in uniform filling, resulting in a high percentage of rejects.

Runners and gates have caused considerable controversy in the closed mold molding technique. We can safely state that this will continue because of the many variables in materials, preheating, and shape and size of parts molded. The most important factors in this method of molding are: the minimum use of pressure because less tonnage is required for clamping large molding areas; the longest possible flow of material with the very minimum of reaction for maximum strength and dimensional stability; the smallest possible runners to prevent waste of materials; the smallest possible gate to minimizing finishing operations. We realize that the above desiratives are contradictory. It is impossible to have all of them; hence, it is necessary to select the most important requirement or a combination of some. As an example of pressure, time of flow, cure, and properties in different types of gating, we have molded ½ x ½ x 5" impact bars with the following gates.

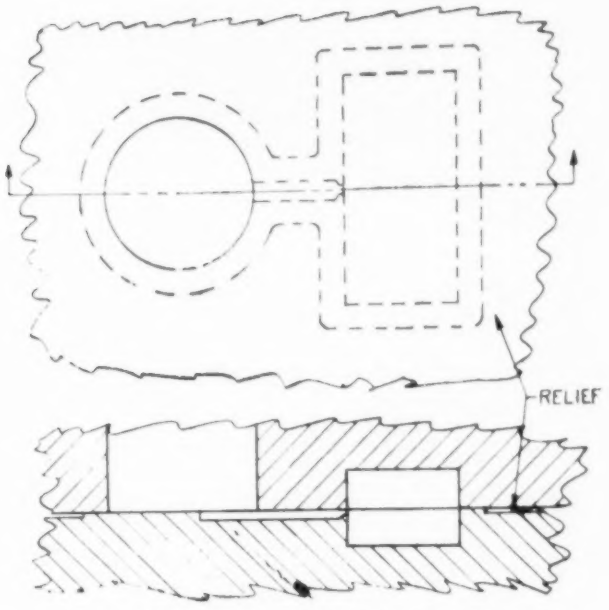


Figure 4. Design of relief area for maintaining a clean mold surface and preventing enlargement of the molding area in case of material leakage.

GATE TYPES SELECTED FOR TESTING			
	Size	Area	Exposed Surface
Gate A	.062" x ¼"	.0155 sq. in.	.625"
Gate B	.015" x ¼"	.00375	.530
Gate C	.040" round	.00125	.125
Gate D	.093" round	.0069	.291

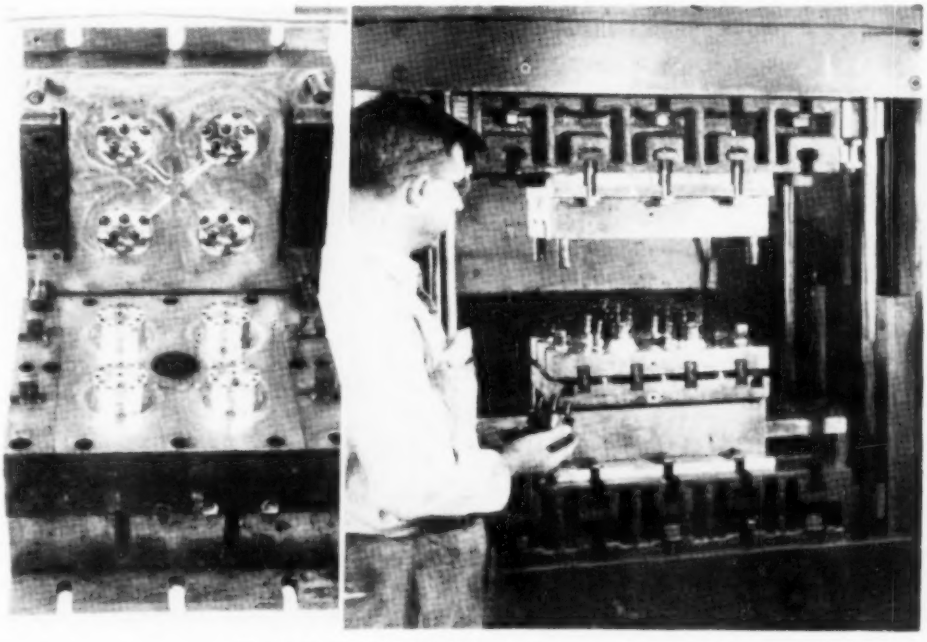


Figure 3. An example of the duplex ram plunger molding method.

These gates are illustrated in Figure 5 below.

PRESSURE AND TIME TO FILL OUT TEST BARS

	Pressure	Flow Time
Gate A	2,500 psi	25 sec.
Gate B	4,500	18
Gate C	5,500	18
Gate D	3,500	20

There is a difference of 120% in pressure between Gates A and C. However, it is not too great when you consider the 1,200% increase in area between C and A gates. Another example is between Gates B and C. There is an increase in pressure of 22% from Gate B to Gate C. However, the area of Gate B is 200% larger than Gate C. Considering the two round gates (C and D), the area of Gate D is 550% larger, yet the pressure reduction is only 47%. Let us consider one more point of pressure, flow and cure. Assuming that we want to extrude a given volume of material in ten seconds, we would require the following pressures and the cure will be as shown in the table below.

PRESSURES AND CURES FOR A GIVEN VOLUME OF MATERIAL WITH FOUR TEST GATES

	Pressure	Cure	Shrinkage
Gate A	3,500 psi	80 sec.	.0126" per inch
Gate B	5,500	60	.0132
Gate C	7,500	45	.0124
Gate D	4,000	55	.0124

These cure time results undoubtedly point out that small circular gating is desirable.

Of course, we must remember that we can only accomplish this by a considerable increase of pressure. There is some intensity of heat in the material going through small gates. For example, maintaining the same plunger time (approximately 18 seconds) and preheating the material to 270°F. and transferring through a large gate into a 340°F. cavity, the material temperature will be approximately 320°F. The same material transferred through a small gate will be 340°F. to 350°F. upon entering the cavity. This is caused by greater velocity as it is transferred through a smaller cross-sectional area, and greater frictional resistance is caused by the advanced material. We must remember that we can only use higher plunger pressures by sacrificing molding area in specific equipment.

Figure 6 illustrates results obtained on general-purpose material using 7/32" diameter runner with a single round gate, two round gates, three round gates, and rectangular gates ⅛" x .016", ⅛" x .032", and ⅛" x .048".

If we followed the theory of hydraulics on the round gates, we would expect twice as much volume from two gates and three times as much from three gates. However, since we are dealing with materials which go through polymerization, we can readily see that for all practical purposes the volume extruded versus time at any of the four pressures is the same on single and multiple gates. Consequently, there is no reason for using any more than one gate. These results sound fantastic. However, if we study the flow and reaction of materials, we can readily see that the flow will generally take the path of least resistance. The center gate is that path, and through it the material flows at a faster rate. With multiple gates the material generally flows in cycles. Because of greater friction and various obstructions, the flow is often diverted from one gate to the other gates, resulting in alternating shots. During these cycles, the material reacts and consequently slows down the flow from all the gates. Summarizing briefly a few high points, the pressures required for approximately the same volume and time on the different gates are as follows:

One round gate	128 grams in 18 sec. at 9,000 psi
Two round gates	128 grams in 17 sec. at 8,500 psi
Three round gates	127 grams in 16 sec. at 8,500 psi
⅛" x .016" gates	129 grams in 18 sec. at 12,000 psi
⅛" x .032" gates	128 grams in 17 sec. at 9,000 psi
⅛" x .048" gates	130 grams in 20 sec. at 8,500 psi

Considering the great area difference between these gates, the single round gate is undoubtedly the best for the smallest area.

Length of Runners—Although there has been too much emphasis on the length of runner, this is one of the important factors in selecting the proper molding pressure. We have been advocating the use of the shortest possible runners realizing, of course, that in certain mold designs it is not convenient to construct short runners. Thus, long runners must be used, although it means the use of much higher pressures, or large areas in the runners and gates. There is a difference of 100% in required pressure between a 2" and an 8"-long runner (figure 7).

To obtain specific information regarding the pressures required for the various shape runners and gates, we have constructed molds with which we conducted tests on 2", 4", 6" and 8" long runners. We have selected four shapes of runners and gates which represent the most widely used types, and these are:

Half-circular	.0383 sq. in.
Rectangular	.0390 sq. in.
Round	.0376 sq. in.
Square	.0373 sq. in.

For all practical purposes the areas can be considered alike. However, the gate area for each runner is intentionally different. We have our tests on approximately a 20-second extrusion time at specific pressures. In the 8" long runner, for example, the half-circular runner is 50% greater than the area of the round gate. Using the rectangular runner, the gate area is slightly larger than the half-circular, yet delivers only 108 grams in 30 seconds. The square runner extruded 116 grams in 22 seconds at 12,000 psi. Again we must remember that the gate area is 100% greater than in the round gate. We can readily agree that it is worth some extra effort to find a way to use short runners, when it means a substantial saving in pressure.

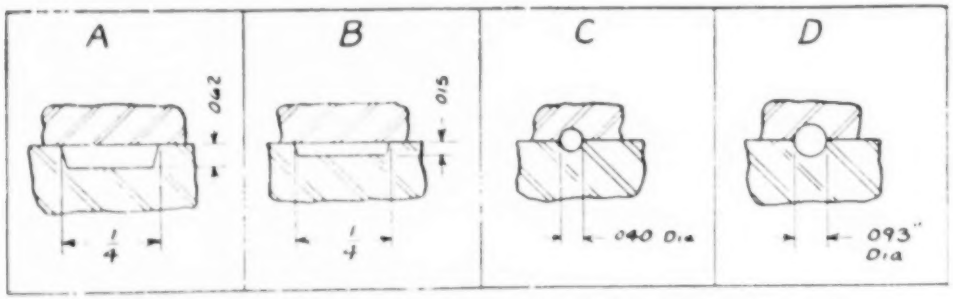


Figure 5. Different gates used to determine pressure, time of flow, cure, and properties as a related to gate types.

Ring or flash-type gating (figure 8) is being used successfully. In this method, the runner is carried half-way into the outer wall of the cavity, and then the flow of the material fans out over the entire cavity wall for approximately .005" depth, thus filling the cavity from the entire circumference. This principle confines the finishing to the tumbling operation. Air venting is a greater problem in this method of gating because the path of air and volatile escapement is sealed off. This is particularly prevalent in parts with dead ends, unless an activated pin is incorporated. Small diameter parts over 1" in length present a filling problem.

Position of gates is often responsible for production difficulties. The location should be where there is a very minimum of flow obstruction when the material enters the cavity. For example, if the flow of the material is obstructed near the gate, it will fill that portion first to about 90% of density and then it will move the semi-set material, filling the balance of the cavity last. This causes internal stresses in the part and many weld strains. The internal stresses and weld strains are responsible for the material cracking around metal inserts. A good example is in the automotive distributor cap. In compression molding, a general-purpose, semi-heat resisting material was satisfactory in every respect. When this part was re-designed for plunger molding, it was necessary to formulate a new and more expensive material before cracking was eliminated. You might think that gating in more than one place will solve the problem. This will only change the position of the cracks. Although faster plunger speed does help, the part will not fill out because there is insufficient time for air escapement. Most successful results are obtained from extra large gates closely approaching compression molding.

Transfer and clamping pressures

It is almost impossible to establish a set standard for calculating the required transfer molding pressures because of the many variables in the molding equipment, mold design, molded part design, as well as the variables previously mentioned. Thin-section parts require higher pressures than thick sections. For example, standard soft, general-purpose material will fill a 34 gram, ½" x ½" x 5" bar at 3,750 psi, but it takes 6,750 psi to fill a ⅛" x ⅝" x 9" bar weighing 18 grams.

Improper pressure is responsible for problems in (1) material stresses, (2) warpage, (3) dimensional stability,

Runner 7/32 Dia

Area - 0376 sq in Exposed Surface - 687 in

	Gates					
	One .062 dia	Two .062 dia	Three .062 dia	.8 x .016	⅛ x .032	.8 x .048
	Gate Area - sq in					
	.003	.0062	.0093	.002	.004	.006
	Gate Exposed Surface - in					
	.196	.392	.588	.282	.314	.346
	791-12 General Purpose					
Pressure	Extrude / Time	Extrude / Time	Extrude / Time	Extrude / Time	Extrude / Time	Extrude / Time
6 000	111 / 50	117 / 55	110 / 50		92 / 60	113 / 55
7 000	125 / 37	126 / 32	127 / 30		125 / 42	129 / 35
8 000	127 / 25	127 / 22	127 / 20		129 / 29	129 / 22
9 000	128 / 18	127 / 15	129 / 9		128 / 17	130 / 15
10 000	128 / 13	127 / 12	129 / 5	121 / 48	129 / 12	129 / 10
11 000				129 / 27		
12 000				129 / 18		

Figure 6. Volume of general-purpose material extruded and time of extrusion at various pressures, through single and multiple gates.

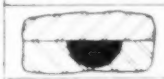
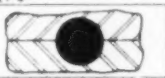
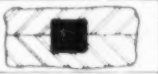
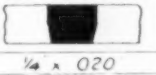
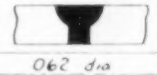
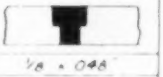
	Runners			
				
	5/16 dia Half Round	5/16 x ⅛	7/32 dia	.193 x .193
	Runner Area - sq in			
	.0383	.0390	.0376	.0373
	Runner Exposed Surface - in			
	.803	.875	.687	.772
	Gates			
				
	7/64 dia Half Round	¼ x .020	.062 dia	⅛ x .048
	Gate Area - sq in			
	.0046	.0050	.0031	.006
	Gate Exposed Surface - in			
	.281	.540	.196	.346
Runner	791-12			
Length	Press / Volume / Time	Press / Volume / Time	Press / Volume / Time	Press / Volume / Time
2	7,000 / 127 / 20	9 500 / 127 / 20	9000 / 127 / 21	9000 / 127 / 22
4	9 500 / 122 / 21	10 000 / 122 / 19	10 500 / 125 / 19	9000 / 122 / 21
6	10,500 / 119 / 20	13 000 / 119 / 20	12 000 / 120 / 18	10500 / 120 / 21
8	13,000 / 114 / 20	13 000 / 108 / 30	13000 / 113 / 22	12000 / 116 / 22

Figure 7. Volume of general-purpose material extruded and time of extrusion at various pressures as a function of length of runner.

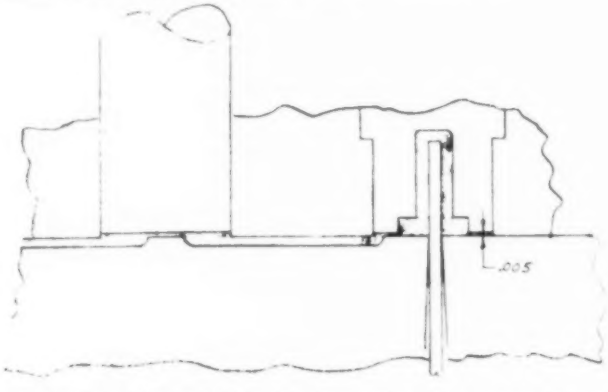


Figure 8. Example of a mold for ring-type gating. The runner is carried half-way into the outer wall of the cavity.

(4) molding, (5) physical properties, and (6) shrinkage of the material. For example, the table below illustrates a soft-grade, general-purpose material molded at various pressures and the wide range of shrinkage obtained.

General-Purpose Material

Mold temperature 320° F. Plunger pressure	H. F. Preheat Shrinkage
10,000 psi	.0084" P. I.
8,500	.0088"
7,500	.010"
6,500	.010"
5,000	.011"
4,000	.0118"
3,500	.012"
2,500	.0124"

This wide range of shrinkage is actually produced by compressing the material beyond its ultimate density, and causing it to expand or grow larger than the mold.

Figure 9 illustrates a method of calculating the pressures, clamping, and molding area for a pot-type mold. Because of the many variables mentioned, we recommend 6,000 to 8,000 psi on a direct sprue previously illustrated, and 50% greater pressure for the sprue and runner combination.

Despite previous publications, including ours on "Transfer Molding Pressures" (S.P.E. News, Vol. 4, No. 1, January 1948) and "Standardization" there are many problems in the industry that are directly related to clamping versus transfer pressure. Theoretically, there is no internal hydrostatic pressure in the transfer mold cavity. This theory, however, is based on a precise coordination of polymerization and exact amount of material, i.e., just as the cavity is filled, the material is solidified at the same time. To accomplish both of these actions simultaneously would be impossible, although, this would be the most desirable condition for best performance and ideal molded parts by the closed mold method. In following some of the information on pressures, runners, and gates in this as well as our previous papers, we believe that closer coordination can be obtained.

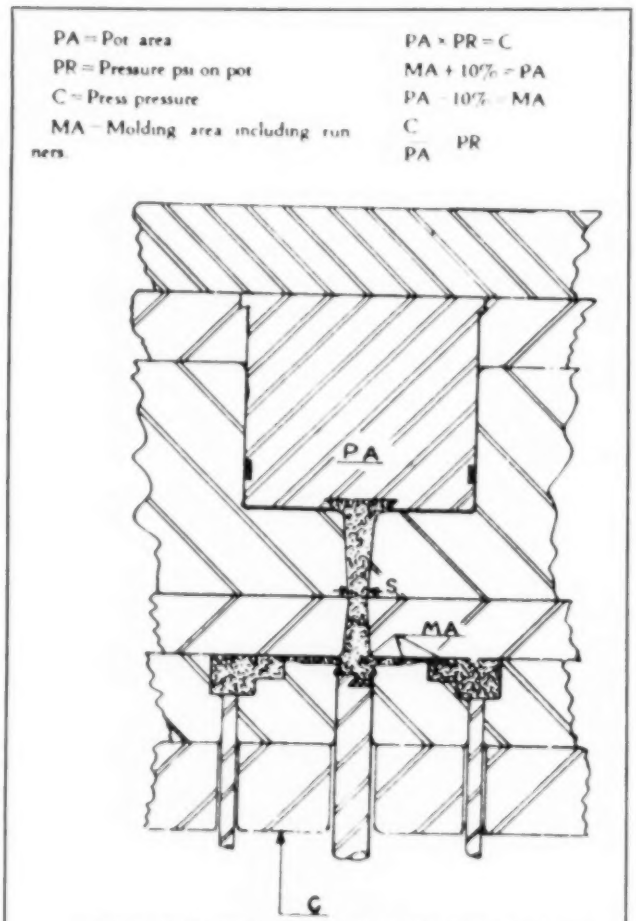


Figure 9. Illustration of a method of calculating the pressures and clamping and molding areas for a pot-type mold.

In our publication on "Transfer Molding Pressures" several years ago, we made the following statements, and I quote, "There are many definite advantages in the transfer molding method over the conventional compression molding. For example, (1) faster cure, (2) delicate inserts and small holes may be safely molded. (3) practically no fin removal after molding, (4) close dimensional accuracy may be obtained provided accurate transfer pressure is maintained, (5) less wear on the mold surface, (6) superior finish, and (7) in most instances, superior physical and electrical properties may be obtained." Some of the above statements are still true but it will be necessary to elaborate considerably on 2, 4, 5, and 7.

Delicate inserts and small holes may be safely molded. This is true regarding location, alignment, minimum of material flowing into the inserts, and pin breakage. However, it is not true in respect to minimum warpage and material cracking around the inserts. Warpage is directly related to internal stresses and molded density. For example, in transfer molding a tubular part (figure 10), the flow of material is never uniform around the cavity. It generally flows up one side as illustrated by A. When this side is partially filled, the flow is diverted to side B, filling it completely, and then it fills side A. By this time, the material is semi set. Side A is molded to the right density while side B is compressed. When the part is ejected from the mold, side A starts normal shrinkage while side B might expand .015" before the shrinkage starts, thus resulting in warpage as illustrated by the dotted line. Circular or ring gates were tried on a similar part in production without any improvement. The material still flows in cycles according to internal resistance and material reaction. Our best results were obtained by lower mold temperature, approximately 290°F., using material of precise flow, and accurate high frequency preheating.

The flow diversion not only takes place on an intricate design, but it is quite prevalent in plain design parts without any obstructions. For example, molding a ½" x ½" x 5" bar, and gating on one end, the ribbon of the material flows directly to the end of the cavity. As soon as it meets resistance, it begins to curl and progressively fills the bar. It is quite evident that the density of the part is not uniform because the ribbon of the material opposite the gate has advanced or semi-cured before the final pressure is applied on the material. In most cases, a one-second pause in flow is sufficient to create microscopic weld marks and these are also responsible for warpage, shrinkage, and cracking of the material.

Cracking of material around metal inserts is a serious problem in the closed mold method of molding. In every instance, when satisfactory results are obtained in compression molding a specific material, cracking can be expected in the closed mold method for equal wall thickness. Generally as much as 100% increase in wall thickness is necessary. In many instances, stronger or more resilient materials must be used.

Cracking of material in machining operations is also a problem and it is related to the many variables in this method of molding. We know of an instance where for many years a compression molded knob was produced without cracking during the drilling operation. Not long ago, we were advised that 30% of the parts were cracking. Investigation proved that they have changed to plunger molding. Density and microscopic weld marks were again responsible.

Close dimensional accuracy may only be obtained by precise coordination of the elements involved. However, since this is economically impractical, greater dimensional variations exist in this method of molding. Of course, we realize that some of these variables also exist in compression molding but to a lesser degree.

Most of the dimensional variations are caused by the compressibility of the material beyond its ultimate density. Phenolic materials can only be densified to a certain point. Excessive pressures, softer material, or more preheat cause expansion or growth of the molded part beyond the mold dimension. Expansion or growth of the material does not function on the inches-per inch basis, but it is generally uniform in all directions. Consequently, erroneous measurements are obtained. For example, allowing a molding shrinkage of .010" per inch on a rectangular part 2½" x 6", it was evident that the 6" dimension was within the tolerance, but the 2½" dimension was not. After rechecking the mold and molded parts, it was learned that the 6" dimension was shrinking .009" per inch and the 2½" dimension .0076". Further investigation proved that this was caused by compression and growth of the part. The part expanded .006" in all directions, thus causing the 6" dimension to shrink .009" per inch and the 2½" dimension .0076" per inch.

Part design is often responsible for these variations. In some instances, thick and thin section parts will shrink differently because of the speed of material reaction in the mold and cooling upon ejection. For example, the table below illustrates a general-purpose material molded in ½" x ½" x 5" impact bars and ⅛" x ⅝" x 9" tensile bar, using .030" and .060" gates.

	Plunger Pressure				
	3,000	3,750	6,500	6,750	10,000 psi
Impact bar					
.060" gate	.0128"	.012"	.0108"	.0094"	.0088"
.030" gate		.0132"	.0124"	.0111"	.0091"
Tensile bar					
.060" gate			.0077"	.0076"	.0072"
.030" gate				.0081"	.0077"

We have previously mentioned that thin sections require higher pressures than thick sections. This illustration is a good example. The .060" gate filled the impact bar at 3,000 psi and the tensile bar at 6,500 psi. The difference in shrinkage between thick and thin sections is not too great at any one pressure. For instance, with the .060" gate at 6,750 psi, there is a difference of .0018" per inch. This, however, is sufficient to cause difficulties in maintaining close dimensional accuracy.

The wearing of the cavities and force surface depends on the material being molded, part design, and pressure. The organic and some of the synthetic fillers have the least amount of abrasive action. The greatest wear is caused by the mineral-filled materials. When the part does not have too many obstructions as in figure 11, for example, the flow of the material into the cavity is not concentrated on any one point. Even if it should be at center pin A, for instance, the wear would be very slight because of lower

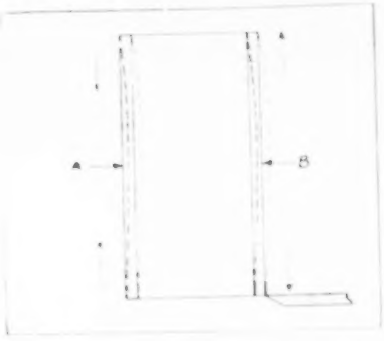


Figure 10. Type of warpage in a tubular part.

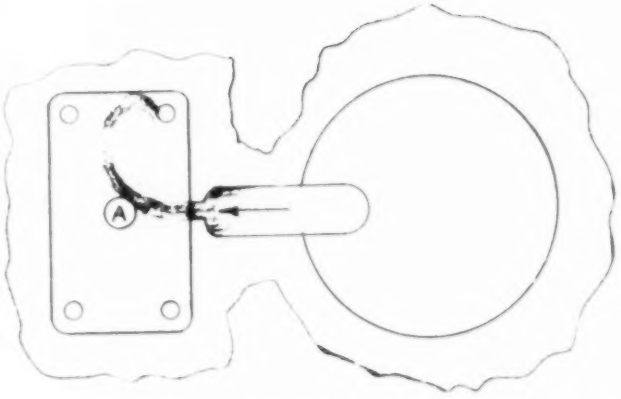


Figure 11. Non-obstructed flow of material into mold cavity.

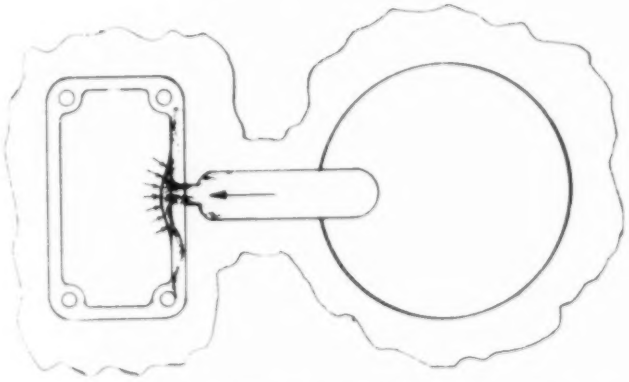


Figure 12. Material striking side of mold directly, resulting in considerable wear at area of impact.

velocity at that point. Diversion of flow away from the pin starts at the instant of contact.

Part design as illustrated in figure 12 presents quite a problem. In this case, the supported flow is concentrated on one point and at full velocity. The effect is the same as directing a water hose nozzle at one spot in the ground. The greatest wear would be in direct line of flow and it will diminish as the flow is diverted and the material starts flowing into non-obstructed spaces. Using a certain type of mineral-filled material, this design will wear the mold as much as .020" in three weeks. By changing location of the gate, less wear is obtained by gating on the top of the side wall as illustrated in figure 13. The flow of the material is concentrated on the end of the gate as indicated by A. This diverts the flow into non-obstructed space. On long production jobs, there will be some wear on the corner of the cavity as indicated by B.

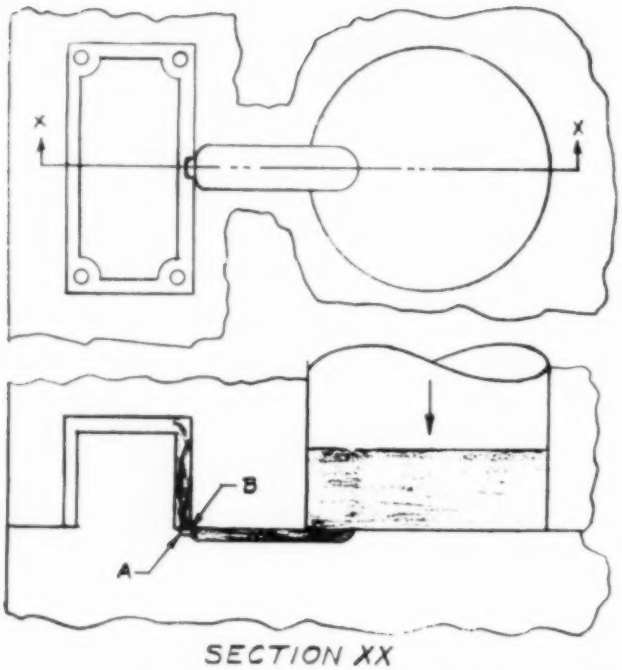


Figure 13. Changing of location of gate from direct side entry (above) to entry at edge (lower sketch) minimizes mold wear.

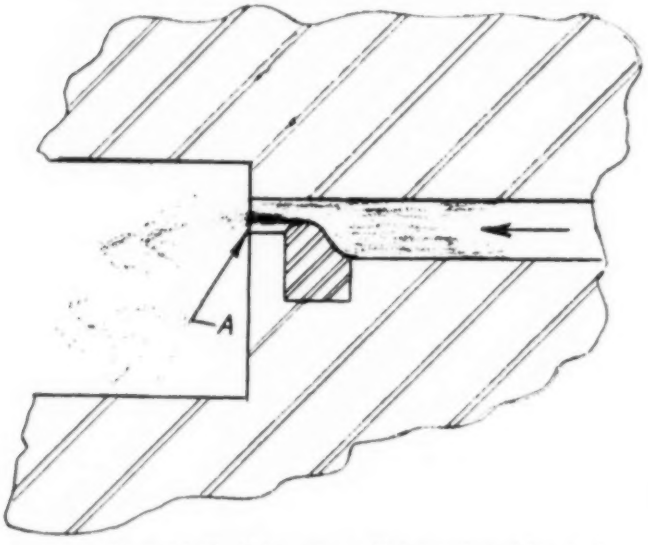


Figure 14. Carbide gates or high-speed steel inserts deflect the flow of plastic and lessen wear on corner of cavity.

Wearing of gates is a problem with any material. In many cases, particularly on long production jobs, carbide gates are the only solution. In some cases, high-speed steel inserts are satisfactory, particularly when using a construction illustrated in figure 14. Corner A will stand up indefinitely because the flow of material is obstructed by the high projection of the insert. Since the material does not expand much after passing this point, there is very little material contact with the corner until the cavity is filled.

Physical properties obtained by the closed mold method of molding vary somewhat with different materials. Generally the properties are **inferior** to high-frequency compression molded properties and **superior** to non-preheated compression molded. For example, the table below illustrates properties obtained on general-purpose material, compression molded non-preheated, compression molded high-frequency preheated, and plunger molded high-frequency preheated.

	Compression Molded		Plunger Molded
	Non-preheated	R. F. preheated	R. F. preheated
Impact Ft. Lb.	.27	.30	.28
Tensile psi	7,000	9,000	8,500
Flexural psi	11,500	14,500	14,500
Dielectric V/M	400	400	400

For all practical purposes, the high-frequency preheated compression and plunger molded properties are very much alike. The non-preheated compression tensile and flexural are lower.

Mica-filled materials show a slight increase in impact and considerable increase in tensile and flexural over the compression molded properties.

	Compression Molded		Plunger Molded
	Non-preheated	R. F. preheated	R. F. preheated
Impact Ft. Lb.	.325	.332	.348
Tensile psi	4,000	5,000	6,500
Flexural psi	9,000	9,000	14,000
Dielectric V/M	500	550	550

Higher impact-type materials like CFI-10 show substantial decrease in properties, particularly in flexural and impact strengths. Actually CFI-10 material becomes CFI-5 when it is molded by the closed mold method.

	Compression Molded		Plunger Molded
	Non-preheated	R. F. preheated	R. F. preheated
Impact Ft. Lbs.	1.25	1.60	.66
Tensile psi	5,000	6,500	4,500
Flexural psi	10,000	13,500	8,000

The Browning automatic rifle butt is plunger molded. This part is molded of CFI-40 material at 15,000 psi and

(Please turn to page 41)

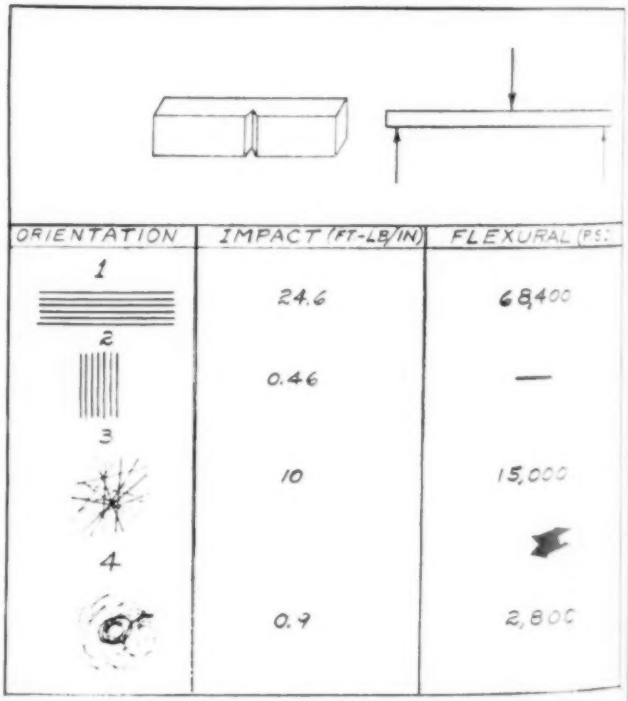


Figure 15. Impact and flexural strengths as a function of the kind and degree of orientation of glass roving-filled phenolic material.

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A contribution from the Professional Activities Committee, Area I, of the Society of Plastics Engineers.

Presented at the Ninth SPE Conference

THIS ARTICLE will deal with a brief description of the principal transfer mold types and a somewhat more detailed statement of the important properties of phenolic materials that affect their transfer molding behavior.

It is safe to say that at present the major part of transfer molding carried out with thermosetting materials in general and with phenolics in particular, is done in plunger or auxiliary ram type molds. These show the most favorable cost comparison with compression molding, and presses designed for these molds are now generally available.

These plunger molds are most commonly of the top or bottom ram type; side ram molds are used much less frequently and usually where design of the part suggests or requires injection of material at the parting line, and where the part is too large to accomplish this satisfactorily from a central well. An example of this is a toilet seat; while these are ordinarily molded by compression, certain special designs have been successfully produced in side ram transfer molds.

The top and bottom ram types have certain inherent advantages and shortcomings. It is difficult to generalize about these, but, at the risk of seeming too categorical, I will point out what I feel to be their respective merits.

Top ram molds are frequently awkward to load, because of the restricted space between bolsters. Also, the presence of the top ram may interfere with the operation of top ejection mechanisms. Theoretically, they should permit faster molding cycles, because the mold is closed and under clamping pressure at the start of the cycle. Exceptions to this statement, however, have been found in certain bottom ram molds operated in presses equipped with automatic cycle timers and sequence valves. These have actually proved faster than top ram molds.

Bottom ram molds are easier to load — the mold is open and the loading well readily accessible at the beginning of the cycle. Normally, and with the exceptions noted above, bottom ram molds may require longer cycles, since the mold must be closed and clamped before the transfer ram is energized. Unless the transfer ram is contained within the main ram, as in some recent press designs, or unless longer side columns are used, some of the press opening or daylight must be sacrificed to provide mounting space on the lower press platen for the transfer cylinder. This problem is encountered where standard upstroke compression presses are being converted for bottom ram operation.

Whatever the mold type, certain design and operating factors are fundamental:

1. The mold layout should be compact, with runners of adequate cross-section, preferably of equal length and certainly as short as possible. Circular arrangements with short radial runners are the most desirable.

2. Venting of cavities is distinctly advisable to permit escape of volatile matter from the molding material as the mold fills. Frequently, successful operation of a transfer mold without venting is impossible.

3. Preheating of the material is a "must" for successful transfer molding. Preferred methods are dielectric and steam preheating. In a few cases preheating in dry circulating air ovens has been found advantageous, particularly with mica-filled phenolics.

Phenolic materials, as a class, are well suited to transfer molding and are widely used in this process. Melamine materials are also generally satisfactory, although some modification of the basic resins may be required to improve transfer flow.

The application of ureas and alkyds in transfer molding is somewhat limited. Their reactivity makes them critical in dielectric preheating and their short flow period and fast cure usually restricts their use to small parts and to transfer molds of simple cross-section.

The widespread use of transfer molding has mightily spurred material development in the phenolic field. Materials now available, based on newly developed resins, exhibit flow and cure characteristics at moderate temperatures and pressures once thought impossible. They are immeasurably superior in these respects to the best

Transfer Molding . . .

materials available just a few years ago. In keeping pace with the growth of transfer molding, we have radically changed our concepts of flow and cure. We used to consider total flow or flow duration of prime importance, without worrying much about the time involved. Now we are vitally interested in flow rates or amount of flow per unit of time, and in much faster cures than those once considered satisfactory.

As the result of a great deal of research in these directions, we now have materials that show as much total flow as the so-called "long-flow" premium materials of a few years ago, but accomplish this flow in a much shorter time interval and then cure up fast and hard. We have combined in these materials the two seemingly antagonistic but highly desirable properties, soft flow and fast cure.

We are saved from any tendency to feel smug and complacent over these somewhat remarkable accomplishments, by the realization that much further progress is possible and that we do not by any means know all that should be known about the factors in phenolic materials that affect transfer molding behavior.

Some of these factors have, of course, been recognized and evaluated. Among these are the following:

Resin type and reactivity
Resin content
Type of filler
Volatile content.

Resin Characteristics

It is generally recognized, I am sure, that to fill out a large, complicated transfer mold, the phenolic material must be free-flowing, or as it is usually expressed, have a soft plasticity. Its flow is aided by dielectric preheating, but the resin on which the material is based must inherently have extremely good plastic flow properties.

This usually means that the resin in the material, as charged to the mold, should have a low melt viscosity, which in terms of resin structure means that it should not be highly cross-linked. However, it must be potentially quite reactive at molding temperature, if fast cure is to be obtained.

For these reasons, most one-stage phenolic materials are not too well suited to transfer molding. Aside from their stability in storage, which leaves a good deal to be desired, they are usually too reactive, too fast-curing to furnish the flow required. They are much better fitted to compression molding of short draw parts, where less flow is required and where their fast cure is a positive advantage.

Two-stage materials, having a longer flow period usually show much better transfer characteristics. When properly reacted and formulated, they show more rapid flow, better gloss and more rigid set on discharge.

This should not be taken to mean that all two-stage resins are satisfactory for transfer molding. This is far from true. Many two-stage resins and molding compounds can be made which are practically as fast curing as the fastest one-stage materials, and much too reactive to be used in plunger molds. It is only by employing special, carefully controlled reaction conditions in making the resin and by special compounding of the molding material that the unique combination of flow and cure required for transfer molding can be obtained.

Resin Content

While important, resin content is not the paramount consideration in a suitable transfer material. Here, as in other molding applications, the resin plays a dual role—it is the vehicle in which the other ingredients are dispersed; it is also the principal reactant, which gives plastic flow to the mass and then polymerizes to a hard, infusible solid in the finished molded part.

One might therefore conclude that transfer flow can always be improved by increasing the resin content of the molding material. Like many other generalizations, this is true only within certain limits. Enough of the right type of resin is required to cover the filler and other ingredients adequately and to permit rapid, free flow into the mold cavities, without excessive transfer pressure. Increasing the resin content beyond this point will usually not improve flow any further; it will obviously increase the cost and may even embrittle and reduce the strength of the molded part.

If the resin has a high melt viscosity, and hence sluggish, stiff flow, and when used in normal concentrations in a molding compound, will not fill the mold cavities completely, increasing the resin content will ordinarily not help matters. The material still will not fill completely and will flash excessively from the runners near the well. While, unfortunately, I cannot present factual data and cite you chapter and verse on this, we have had ample laboratory evidence to support these rather broad statements.

Fillers

Fillers used in phenolic materials are more than mere diluents. They reduce cost, it is true, but they also increase mechanical strength, reduce shrinkage, and in the case of such inorganic fillers as asbestos or mica, improve heat resistance and electrical properties of the phenolic resin.

Standard fillers for phenolic materials are still those which have been well known for years—woodflour, cotton flock, asbestos and mica. Various shell flours have been used with some success, and nylon is being used in special electrical grade materials.

We are continually examining new possibilities. It seems to us that everyone who accumulates a pile of gunk as an industrial processes by-product, or finds a large deposit of some queer clay on the old farm, sooner or later asks us to try it as a filler. We have, over the years, examined such diverse substances as corn cobs, hemp hurds, slate flour and extracted coffee grounds.

Some of you will now feel that your worst suspicions have been confirmed and will remember and confront me with this statement the next time you have trouble molding a phenolic material. Let me reassure you immediately —none of these materials has been found satisfactory. We do not use any sandalwood, sassafras, sago starch or slippery elm in the material — just plain old-fashioned sawdust.

The various organic and inorganic fillers used vary

(Please turn to Page 42)

Glass Bonded Mica

J. H. DuBois

Mycalex Corporation of America
Clifton, New Jersey

Glass bonded mica is one of the older materials, having been in commercial use since 1921. It is exactly what the generic name implies, a molding compound formulated of glass and mica—sold under a variety of trade names*. Glass bonded mica materials have served the market for products requiring complete dimensional stability, and for high frequency, high voltage and high temperature applications. This market is also served in a small way by the thermosetting resin bonded mica compounds.

THE newer organic plastics such as tetrafluoroethylene, trifluorochloroethylene and silicone glass have provided partial answers to many of the high temperature, frequency and voltage insulation requirements. Research and development work with organic plastic and glass bonded mica points the way to many new and important solutions to the problems concerned with the selection of materials and the design of insulation for high temperature and high frequency work.

The important contemporary materials in this field are listed in Table 1 and a comparison of the range of values will emphasize again the complex character of plastics material selection. No one material has a monopoly on good properties; each has many good points and several properties wherein it is weak. The designers problem is to find the *one* material with the best balance of properties for his application and then to design the insulator in such a way that the design will compensate for weaknesses that must be met by means of mechanical design features.

Tetrafluoroethylene for example, has an extremely low loss factor, excellent arc resistance, high dielectric strength, nil moisture absorption, but being slightly elastic, cannot be produced with dimensional precision and is distorted under pressure. It cannot be used conveniently as a structural part in many cases which require superior electrical properties, because of its low heat distortion point and its poor corona resistance. Steatite, a ceramic, has a very high heat distortion point, good electrical properties, nil moisture absorption, but cannot be produced economically with tight dimensional control and is very poor in thermal shock resistance. Trifluorochloroethylene has good electrical properties, nil moisture absorption, is quite stable dimensionally under exposure conditions but has a low heat distortion point and may not be used structurally when stressed at elevated temperatures; like the other organic plastics, it also lacks corona resistance. Glass bonded mica has a high heat distortion point, good electrical properties, nil moisture absorption, permanent dimensional stability, is unaffected by corona and radiation, is low in impact strength and high in specific gravity.

The high heat distortion point (650°F.) of glass bonded mica, its precision dimensional and insert moldability, complete age and dimensional stability and low loss factor makes it an important structural material for thermal, electronic and high voltage components. Very complex molded parts with heavy or frangible inserts are possible as shown in Figure 1. Printed circuits that connect with molded-in metal components are practical because glass bonded mica will take the firing temperatures required for silver paste; the organic plastics are unsuited for this use because of temperature limitations—and the ceramics, which can take the firing temperatures, cannot be molded with inserts. It will be noted that of the

Figure 1. Complex and fragile inserts may be molded in glass bonded mica products.

(*) *Glass bonded mica*: *Mycalex*, *GE-mycalex*, *Mykroy*, *Insanol*.

TABLE I. COMPARISON OF GLASS BONDED MICA WITH OTHER INSULATING MATERIALS

	GLASS-BONDED MICA "MYCALEX 410"	"MYCALEX 400"	"MYCALEX 410X"	STEATITE	* MICA-FILLED PHENOLIC	* ALKYD (Polyester Molding Compound Mineral-Filled)	* MELAMINE (Asbestos Filled)	* GENERAL PURPOSE PHENOLIC (Wood-Flour Filler)	* "TEFLON"	* "KEL-F"	* POLYSTYRENE	ELECTRICAL GLASS	PORCELAIN
Dimensional Precision and Stability	A	A	A	C	B	B	C	C	C	B	B	B	C
Heat Distortion, °F	650	700	650	1800	230-350	350-400	265	260-340	266 (66 psi)	160 (66 psi)	200-210	925-1679	2200
Thermal Expansion/°C	10×10^{-6}	10×10^{-6}	10×10^{-6}	7×10^{-6}	19×10^{-6}	35×10^{-6}	$20\text{-}45 \times 10^{-6}$	$30\text{-}45 \times 10^{-6}$	99×10^{-6}	45×10^{-6}	78×10^{-6}	$3.3\text{-}13.0 \times 10^{-6}$	5×10^{-6}
Power Factor 10^6 cycles/sec.	0.0015	0.0018	0.012	0.0025	0.005-0.013	.014-.018	0.041-0.050	0.03-0.07	.0002	.0082	.0001-.0002	0.0006-0.009	0.008-0.01
Dielectric Constant 10^6 cycles/sec.	9.2	7.4	6.9	5.8-6.3	4.2-5.2	4.6-4.9	6.1-6.7	4.0-7.0	2.0-2.05	2.43	2.40-2.42	4.0-7.2	6.5
Loss Factor 10^6 cycles/sec.	0.014	0.013	0.08	0.014-0.016	0.021-0.068	0.064-0.088	.25-.33	.12-.49	.0004	0.020	.0002-.0005	0.0024-0.065	0.05-0.07
Dielectric Strength $\frac{1}{8}$" thickness, volts/mil													
25°C (Step-by-Step)	400	500	400	240	250-390	325-335	320	100-375	430	390	600	500	200
100°C (Step-by-Step)	400	500	400	240		508-525+						500	200
ARC Resistance ASTM Seconds	250	300	250	500	Tracks	190+	120-140	Tracks	700	360	70-130	500	500
Mold Shrinkage, in./in.	nil		nil		0.0005-0.005	0.004-0.007	0.005-0.007	0.004-0.009	.005-.010	.005-.010	.02-.05		
Tensile Strength, PSI	5,000-7,000	6,000	5,000-7,000	9,000	5,000-7,000	3,000-4,000	5,500-7,000	6,500-8,500	1,500-2,500	5,700	8,500-9,500	8,000-14,000	4,500
Compressive Strength, PSI	23,000-27,000	35,000	27,000-30,000	80,000	15,000-25,000	18,000-20,000	30,000	22,700-36,000	1,700	32,000-88,000	12,000-13,500	60,000-175,000	40,000
Flexural Strength, PSI	12,000-14,000	15,000	12,000-14,000	20,000	8,000-12,000	8,000-10,000	9,000-11,000	8,500-12,000	2,000	8,200	12,000-13,000	11,000-16,000	11,000-18,000
Modulus of Elasticity, PSI	7.2×10^6	11×10^6	8.0×10^6	12×10^6	$3.0\text{-}5.0 \times 10^6$	2.5×10^6	1.6×10^6	$0.8\text{-}1.2 \times 10^6$	$.058 \times 10^6$	$.226 \times 10^6$	$.017\text{-}.47 \times 10^6$	$7.1\text{-}11.5 \times 10^6$	10×10^6
Impact Strength, Izod ft.-lbs./in. of notch	0.70	1.85	0.60	1.90	0.30-0.38	0.30-0.35	0.28-0.40	0.24-0.60	4.0	3.62	0.30-0.45		0.70-1.25
Water Absorption, 24 hr. $\frac{1}{8}$" thickness, %	nil	nil	nil	0-0.05	0.01-0.10	0.5-0.8	0.08-0.14	0.3-1.0	nil	nil	0.04-0.06	nil	0-0.5
Specific Gravity	3.8	3.0	2.6	2.7	1.75-1.92	2.18-2.22	1.70-2.00	1.32-1.55	2.1-2.3	2.1	1.05-1.07	2.13-3.18	2.35-2.45

*Figures in columns so marked from 1952 Plastics Properties Chart, courtesy Modern Plastics Encyclopedia. Dimensional Precision-Stability: "A" rating indicates no shrinkage during and after molding and excellent dimensional and age stability under all exposure conditions. "B" rating indicates appreciable molding shrinkage but good stability under exposure conditions. "C" rating indicates shrinkage on molding and during ageing. Firing or dimensional change under exposure conditions.

available materials suitable for high temperature and high frequency use, glass bonded mica has the best balance of properties for products requiring structural precision insulation.

HIGH TEMPERATURES

The miniaturization programs of the Signal Corps, and the fast growing demand for structural and functional components demanding even higher firing temperatures for the printed circuit silver pastes, has initiated the development of glass-bonded synthetic mica. Natural muscovite mica and natural phlogopite mica, are the commonly available types that are used for the conventional glass bonded mica products. Both have hydroxyl-ions in their crystal structure and this precludes high temperature use. The synthetic mica, fluor-phlogopite, has no hydroxyl and can be heated to 2000°F., for several hours while natural micas bloat and lose strength far below this elevated temperature. The top safe limit for natural micas ranges from 1000°F. to 1500°F. Whereas there is no material on the market with good electrical properties at 900°F., glass bonded synthetic mica has a low loss factor at this high temperature. A most important gain is increased refractoriness; printed circuits have been fired on glass bonded synthetic mica at 900°F., with no bloating or distortion.

Mycalex Corporation of America has leased the facilities of the Bureau of Mines at Norris, Tennessee, to gain pilot plant experience with the production of synthetic mica, preparatory to the design of full production facilities. A glass research program has been initiated at their Clifton Works to develop a suitable glass that will measure up to the high temperature potentialities of synthetic mica. Since the synthetic mica top limit will exceed the temperature limitations of mold steels, the glass temperature research program is being confined to the range in which steel molds can be maintained in precision dimensional control. Current molding practice makes use of preheating at 1300°F., and mold temperatures of 800°F. The glass requirement for synthetic mica must fall in the "low" temperature range (1500°F.), and have excellent electrical properties and be highly resistant to water vapor.

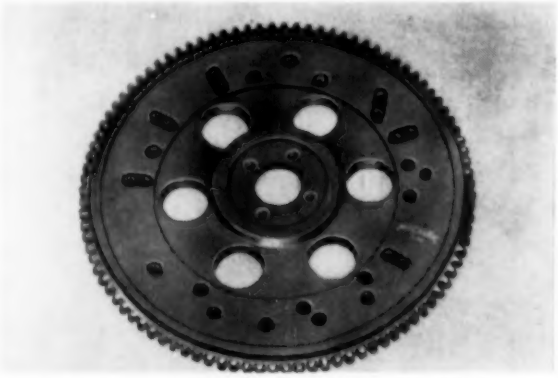

Figure 2. The stainless steel gear extends only 1/16 inch into the glass bonded mica, and there is no loosening of the gear over the temperature range of -50° to +150° Centigrade.

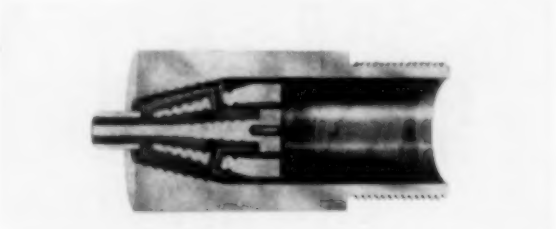

Figure 3. This high pressure electrical seal withstands 350 pounds of air pressure, taking full advantage of closely matching thermal coefficients of expansion.

Table II

THERMAL EXPANSION COEFFICIENTS OF "MYCALEX 410" GLASS-BONDED MICA AND INSERT METALS

Platinum	— 88 x 10-7 / degree C.
Illium R	— 92 "
Mycalex 410	— 100 "
Type 446 Stainless Steel	— 105 "
Inconel	— 115 "
"430"	— 118 "
SAE 1010 Steel	— 121 "
Nickel	— 130 "
Monel	— 140 "
18-8 Stainless Steel	— 160 "
Copper	— 177 "
Nickel Silver	— 180 "
Red Brass	— 188 "
Silver	— 191 "

FLUOROCARBON FILLERS

Concurrently, a program of investigation is being carried on to evaluate synthetic mica filled tetrafluoroethylene and trifluorochloroethylene. Filled organic plastics, in general, exhibit substantial variation in loss factor and dielectric constant. The filler, moisture content of the filler, and the presence of electrolytic contaminants cause this considerable variation. Pure synthetic mica, which may be molded at high temperatures and is free of combined moisture, produces a good low loss compound with improved dimensional stability. Preliminary results indicate an excellent intermediate material that will overcome some of the weaknesses of organic plastics for certain applications, thus providing other new and useful materials in the high temperature, high frequency field with improved electrical properties.

Glass bonded mica provides the designer with a most useful product combination, as a result of its low differential expansion rate when molded with inserts. Thermal expansion coefficients of various metals and plastics are given in Table II. It is noted that glass bonded mica and 446 stainless steel match very closely and it is possible to produce tight inserts over a large temperature range. Figure II, with many of the metals listed. Glass bonded mica components may be cemented directly to the ferrites and certain metals with no thermal loosening as a result of the closely matching thermal coefficients. Parts with inserts, as molded, may be gas tight and one high pressure electrical seal, Figure III, has been tested and found to withstand fluid pressures of 350 lbs., with no leakage along the inserts; with a secondary treatment, this same seal withstood fluid pressures up to 2500 psi. Hermetic seals with excellent thermal shock resistance have been produced in the laboratory; continued work on production methods indicates that they will soon be run in volume production.

ELECTRICAL DESIGN

Full consideration of electrical design fundamentals very frequently indicates glass bonded mica because of the favorable balance of properties. Many basic electrical considerations are overlooked in the design of insulators for lack of appreciation of the problem involved, which goes far beyond ordinary calculations based on tabular data covering arc resistance, dielectric constant, loss factor, dielectric strength, frenquency, current, and temperature range. Other important considerations to be met are space factor, safety factor, altitude, dirt, moisture, contaminants and electrical disturbances from adjacent apparatus. High voltage applications are particularly troublesome, and the problem is increased in miniaturized products. See Figure 4.

Electrical insulation dielectric breakdown is caused by heat—resulting from nearby radiant sources and from internal electrical losses. Loss factor is the common index of insulation quality, representing the product of dielectric constant and power factor from the power loss formula. Loss factor truly expresses the relative rate that electrical energy is lost within an insulator at the given frequency; a material may have a high dielectric constant and still have a relatively low loss factor. Power losses increase with temperature, frequency, voltage, moisture content and occluded gases. Thus, it can be seen, that low power losses require insulating materials which have no moisture absorption and are free of internal voids.

LOW LOSS APPLICATIONS

Many plastics materials fail in low loss applications because of their high thermal expansion coefficients which introduce an air-gap between the insert electrode and the insulator, as temperature change brings on the large differential expansion noted previously. Glass bonded mica products absorb no moisture or gas, maintain the tightness of inserts as temperatures rise, and hold fairly low power losses over the operating temperature range. Insulators having a high dielectric constant but low loss factor are particularly desirable in high voltage, high frequency apparatus because the stress concentration around the metal insert is more easily dispersed; this factor explains why tetrafluoroethylene, trifluorochloroethylene and other low dielectric constant insulators sometimes fail when glass bonded mica stands up. Pressurized high voltage apparatus permits the use of voltages far above the limit of the insulator at ordinary pressures, and this again indicates the absolute necessity for hermetic seals and inserts that will not loosen at elevated temperatures.

INDUSTRY GROWTH

During the last thirty years, we have witnessed a tremendous growth of the organic plastics and the electronics industries; it is noteworthy that through this entire period, a ceramoplastic, glass bonded mica, has retained its large use and leadership in the high temperature, high frequency field. Its good balance of properties: moldability, (Figure 5), precision dimensional stability, low thermal expansion differentials, low electrical loss, zero moisture absorption, high temperature stability and arc resistance are the paramount factors that have extended the use of glass bonded mica products in competition with new materials that can be molded more easily and may cost much less. The product engineer measures the value of an insulator in terms of the benefits obtained and buys when desirable benefits are worth more than the price asked.

It is particularly significant, that much of the plastics development work in the past was predicated on the use of the man made synthetic resins combined with natural fillers. Now we shall reverse that direction, making use of natural "resins" in the form of improved glass and man made fillers in the form of synthetic mica, gaining untold dividends in plastics materials with improved thermal and electrical properties.

Figure 4. This glass bonded mica high frequency coil form demands gauge-like dimensional accuracy combined with the best obtainable electrical properties.

Figure 5. Glass bonded mica is injection molded in auxiliary ram presses with transfer type molds. Preheating is accomplished in gas fired rotary furnaces shown at the left of the operator.

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Vacuum Forming

E. B. Stratton, Jr.

Auto-Vac Company

Presented at the Ninth SPE Conference

THE VACUUM FORMING process, due to the wide range of application and the relative simplicity of production, has become the leading sheet forming method in the thermoplastic field. The process is proving itself in the forming of new products which could not be made economically by the older plastic processes. To date there have been no vacuum-formed applications which represent a replacement of parts previously fabricated by injection or compression techniques.

Until 1950, the use of the process in the commercial field was restricted to three of four plants with any sizable production. The technology of the process in regard to heating, vacuum engineering and equipment design was a closely held secret. The publicity surrounding the production of pre-printed vinyl relief maps, plus the appearance on the market of large quantities of three dimensional Christmas and advertising displays, has encouraged a large number of experimenters, plus a few highly successful producers, to develop the potential of this process.

Basically, the process involves the co-ordinated use of surface heaters, capable of providing uniform heat over large areas, which are positioned over plastic sheets to within an inch and a half of the sheet surface. The plastic sheet is clamped at the edges on a vacuum mold, without pressure during the heating cycle, and after a controlled heating cycle, the vacuum is released. The air between the mold surface and the hot sheet is withdrawn suddenly and rapidly. Upon cooling, the sheet regains its rigidity and can be removed from the mold with the form closely developed.

Considerable testing and development work has been accomplished to engineer for the rapid handling of large volumes of air. In addition, it has been found necessary to design heavier equipment to withstand the shock of vacuum surges applied over large areas. It is always a surprise to realize that when a sheet of plastic 20" x 50" is being vacuum formed, a total load of approximately 13,500 lbs. is exerted on the molding area in less than a second.

This process should be differentiated from acryllic sheet forming production wherein draping and slow vacuum techniques are used. These heavy gauge materials retain their preheat temperatures long enough to permit slower forming methods. In addition, sheet forming methods such as swaging a heated sheet with matching dies, plug molding, blow molding, and slip ring forming are quite dissimilar, inasmuch as these techniques for the most part employ plastic sheets which are preheated away from the dies and subsequently transferred to the die area when pressure is supplied.

The advantages of the vacuum forming process are:

1. The use of preprinting techniques. Heretofore, hand painting or masking and spraying of art work on finished molded parts has been so costly laborwise, that such applications as displays, toy parts and decorative applications were severely restricted. With the uniform pressure and heat used in vacuum forming, it is now possible to silk screen or lithograph art work on flat plastic sheets and then to control the position of the printed sheet on the mold and form the sheet so that the printing registers with the molded pieces. These techniques have been successfully used on molds requiring as many as sixty individual pieces of art work on one sheet of plastic.

2. Great flexibility in choice of plastic materials, sheet sizes and sheet thicknesses. Vacuum forming equipment, properly designed, can handle the entire range of thermoplastic sheet materials, sheet sizes from ten square inches to forty square feet can be processed. Plastic films as thin as .001" can be fabricated with the same facility as the forming of ⅛" sheets.

3. Samples can be rapidly produced. It is possible to fabricate samples in a matter of two to three hours. This factor facilitates market testing and the quick development of product design. In a five hour period a fabricator can now show a toy part, for instance, in four or five gauges, of three or four materials. Design changes can be accomplished overnight, where formerly six to eight weeks were required. In addition, the low cost of plastic test molds cuts the expense of product design and development to a minimum.

4. No delays between final product design and start of production. The building of production mold set-ups, the fabrication of the molds themselves, and the engineering of the finishing operations can usually be accomplished in three to four weeks. None of the above equipment is complicated or difficult to assemble. In most instances fabricators are able to perform their own production engineering. Changeover from one production set-up to the next is simply and rapidly achieved.

5. Large and small parts can be produced at a fast rate per man hour. Fabrication of thin gauge sheets up to .020" can be accomplished at the rate of 80 sheets per man hour. Thus, using a sheet 26" x 52", it is possible to obtain 1200 8" x 10" rigid vinyl trays per man hour. At the same time, .080" high impact styrene refrigerator inner door panels requiring sheets 40" x 72" with draws up to 6" could conceivably be produced at the rate of 45 pieces per man hour, which is fast when compared to other means of fabrication.

In the order of their present volume usage, the following sheet materials are being successfully fabricated:

1. Rigid vinyl copolymer materials are most commonly used for the entire application range from thin to heavy gauge sections. Relief maps, Christmas and advertising displays, toy parts, containers, lighting fixtures, etc.

2. The deep embossing of flexible vinyl is a rapidly growing field. The uses are place mats, bath mats, wallets, materials for ladies' pocketbooks, table cloths, inflated novelties, masks, etc.

3. The styrene copolymers, principally Dow high im-

pact Styron, are being used in increasing volumes for industrial component parts of refrigerators, shower baths, washing machines, television and radio cabinets and many other household applications.

4. Cellulose acetate and cellulose acetate butyrate lend themselves to transparent packaging applications when thin gauges permit visual packaging at minimum materials cost. These materials are also being used for small decorative containers in the cosmetic and toy industries.

5. Straight styrene sheet offers superior qualities in rigidity and dimensional stability; however, certain problems of fabrication and finishing have so far retarded wide spread usage.

6. Polyethylene and Teflon sheet materials perform excellently for this process and offer many interesting potential applications. However, the limited availability of polyethylene and the high cost of Teflon have prevented the growth of product development in these materials.

THE GROWTH OF THE PROCESS.

1. In 1950 there were approximately three commercial fabricators with a maximum of eight machines using the vacuum forming process. At the beginning of 1953 there are at least 70 fabricators with approximately 125 machines.

2. The biggest applications today are: advertising and Christmas displays, deep embossed flexible vinyl, industrial component parts.

3. The largest uses now under development are: packaging, visual and profile containers, snap on lids, toys, inflated novelties, and lighting fixtures.

As the use of this process increases, so does the requirement for refinements of the techniques and improvements in equipment.

1. The expanded use of the preprinting procedure has developed a need for better printing methods, improved metallic coatings, flocking techniques and less expensive laminating processes.

2. The use of differential heating of the plastic sheet has been found important to overcome excessive thinning of certain areas in moldings. By pre-masking the sheet during the heat cycle, it is possible to strengthen weak spots. The masked area is not heated as high as the unmasked areas and therefore will not stretch uniformly when the sheet is formed. In some instances it has been possible to triple the thickness of weak points by this method.

3. Two-stage forming techniques are important adjuncts to the process. In one case, the die plug is forced into the hot sheet before vacuum is applied. In the other case, the clamping frame is retracted after the sheet is at optimum temperature. In the latter instance the sheet is drape-formed prior to the release of vacuum. These two-stage techniques improve equal distribution of material throughout the formed piece and also make possible deep draw applications heretofore impractical.

4. The technique of encasing or embedding wood cores in a covering of vinyl, butyrate or styrene sheet is still in the experimental stage. It is entirely feasible to place laundry hamper cores or toilet seat cores in a mold and form sheets of .015" or .020" plastic over and around the cores so that the resulting undercut locks the covering in place. At present these applications are being processed by hand and in a restricted range of materials.

5. Many developments have appeared in die construction and materials. The use of metal sprayed shells has been well publicized; however, the understanding of the handling of these metal alloy shells is still under development. Reinforcing the surface of plaster production molds by impregnation with Epoxy casting resins is a new technology. There are case histories of such treated molds which have successfully withstood over 50,000 impressions. The use of resin-impregnated wood molds has proven very satisfactory. With proper coating methods a high polished resin surface is possible. These coated surfaces successfully withstand repeated heat cycles without degradation.

6. Metal inserts have been successfully formed as integral parts of pieces. Such inserts as reinforcing rings, sheet metal shelves, bosses, etc., are now being used in production.

7. Methods for controlling mold temperature are still being tested. The most successful design appears to be the use of lead, zinc, copper or tin tubing which is soldered to the metal die shell for circulating water at a controlled speed to obtain a constant mold temperature.

With the advent of increasing numbers of new fabricators using the vacuum forming process, it is expected that a great many new technological developments will appear to further expand the use of the process. New ideas for applications and new product designs will also help this expansion.

Although there have been many skeptics who feared that the plastics field could absorb only a limited number of vacuum machines, time has proven them wrong. The individual fabricators are developing this process with originality and ingenuity in the same manner and rate as did the pioneers who first developed the injection molding process.

Vacuum Forming

Robert Butzko

Robert Butzko

Auto-Vac Company

Presented at the Ninth SPE Conference

One of the questions asked most frequently is "Can vacuum forming compete with injection molding." The answer is yes within certain limits of design but in general vacuum forming is creating its own field which in turn contains many items which cannot be injection molded. It is obvious that many items with inserts and complicated interiors cannot be vacuum formed.

IN SPEAKING WITH a leading custom molder he tells me that only one out of 5 of the jobs he estimates results in a production run. Many do not materialize because of high tooling costs, long tooling period, low rate of production, and high piece cost. We estimate that of the last 4 jobs, one could be a vacuum forming job.

I know of one job which requires over 1,000,000 pieces almost one foot square which competed with injection molding successfully. One vacuum machine with an 8 cavity mold will finish the job in 120 days on a single 10 hour shift; whereas in injection machines working on the same basis would require 2 cavity molds and need over 250 days to complete.

While it is true that sheet material costs 1½ to 2½ times as much as molding powder, vacuum forming is practical for the following reasons:

1. Since sheet material is generally stronger and less subject to stress, thinner materials are used. The vacuum forming people take a lesson from the steel people who have in general replaced heavy castings with thin sheet steel ribbed to increase strength.
   Thicknesses of .010" to .030" which are common in vacuum forming are virtually impossible in injection molding.
2. Machines are less costly than injection machines, averaging from ½ to ⅓ less for machines whose capacity is approximately 10 times by weight.
3. Mold costs are only about 1/20-1/30 of injection mold costs.
4. Cost of operating is less than injection molding.
5. Coloring and decorating is far less because this operation can be done in the flat sheet.

MACHINES

In the vacuum forming field the machines are in general of much simpler construction but are also **much larger in platen area than injection machines.** Whereas injection machines are figured in ounces and square inches of platen area, vacuum machines are figured in square feet of platen area and **maximum depth of draw.** Depth of draw is limited only by the vacuum tank size, the vacuum pump size and the vacuum value.

The platen size is generally patterned after:

1. Size of various plastic materials
2. Size of various printing presses

Size of the vinyls and acetate sheets is approximately 20 to 23 in width to 50" long. This makes the dimension of a so-called sheet machine as 24" x 50" or 8 square feet. This is in general considered the most useful size for general purpose work at the present time.

If we can then draw a comparison between this machine and the 8 ounce injection machine, it would be as follows:

8 oz. Inj. Mach.		Full Sheet	
Platen	90 sq. in.	8 sq. ft.	1200 sq. in.
Cost	$15,000	$6000	
		Largest possible pc. 80 oz.	

12 oz. Inj. Mach.		36" x 50" Mach.	
Platen	130 sq. in.	12 sq. ft.	1800 sq. in.
Cost	$20,000	$7000	
		Largest possible pc. 120 oz.	

16 oz. Inj. Mach.		42" x 72" Mach. Dow Styron Sheet	
Platen	180 sq. in.	$9000	19½ sq. ft.
Cost	$35,000	Largest pc. 200 oz.	

From the above it is seen that the capacity of a vacuum machine is in general higher than injection machines and the cost lower.

COST OF OPERATION

In general the costs of operations of vacuum molding equipment are less than injection molding which is best shown by the approximate rates currently in effect for running molds (injection).

8 oz.—$ 7/hr.
12 oz.— 10/hr.
16 oz.— 12/hr.
60 to 80 oz.— 20 to 30/hr.

For vacuum forming the rates run from $6 to $9 an hour at the present time.

MOLDS

Molds used in vacuum forming are far simpler than their injection molding cousins. Generally molds are made of plaster or metals of the softer variety.

MATERIAL—Plaster molds are made of the harder plasters such as U. S. Gypsums "Hydrocal" or Certainteed Products "Donsite." These are usually re-inforced with screening to prevent breakage.

COST—Costs of plaster molds are about $30/40 sq. ft. when cast from a master and about $20/sq. ft. for the clamping frame.

When a plaster mold is complete it is impregnated with material such as an epoxy resin. Bakelite's C8 resin has produced excellent hard durable surfaces on molds.

LIFE—Large plaster molds are still in operation after 50,000 pieces on 3 shift operation and many months of continuous operation.

Metal Sprayed Molds are pretty much permanent molds which will last the life of the products. These are made by spraying coatings of various metals such as lead, zinc, tin and copper on a master up to a thickness of ¼". When removed it must be backed up with plaster, polyester and glass or various compounds to prevent breakage.

Costs for spraying are about	$75/sq. ft.
Backing up	15/sq. ft.
Clamping frame	20/sq. ft.

Molds in service have produced 500,000 pieces and are still in good shape.

Plated molds are higher in cost than metal sprayed molds and figure $125/sq. ft. However, large molds are difficult to make and are not too readily available. However, they are excellent molds. The average time for a plaster mold is from 3 to 10 days. For a sprayed mold from 1 to 3 weeks. For a plated mold from 3 to 5 weeks.

These molds compare to injection molds which run about $3000/sq. ft. and upward of 10 weeks for delivery.

MOLDING CYCLES

Timing of vacuum molding depends upon the thickness of the material used and in general the following chart can be used for the heating cycle.

Rigid Vinyl	7 Sec.	.010 of thickness
Flex. Vinyl	12 Sec.	
Acetate 1	13 Sec.	
Styrene Copolymer	8 Sec.	
Butyrate	10 Sec.	

The above results are obtained using a 700°F. heater approximately 2 inches from the sheet.

Overall cycles are approximately as follows:

On gauges from .010 to .030 1½ to 2 shots/Min.
On gauges from .030 to .040 1 shot/Min.
On gauges from .050 to .080 30 to 40 shots/Min.

Usually both the heating and cooling cycle are micro timed on rigid material to give greater uniformity to the product.

DIE CUTTING

Cutting of the formed pieces is accomplished by the use of dinking machines, clickers or crank presses and the use of high dies.

With a clicker or dinking machine a sharp blow to the top of the die will cut thru the plastic. Usually enough pieces are stacked on each other so that the pile reaches ¾" thick. The clickers cost from $600 for a 12" machine to $1200 for a 24" head. With 2 strokes a 36" piece is cut on a 24" head. Dinkers are about 26" x 50", cost $3000.

Dies cost from $75 to $300 and will last hundreds of thousands of pieces. About 750 to 1500 pieces per hour about 1 sq. ft. each is good production on a clicker.

PREPRINTING

Probably the greatest advantage of vacuum forming is the precoloring of the sheets prior to forming. This means that a preprinted piece when placed in a mold and formed will register in the correct place on the formed piece. Various techniques are used to prepare and figure this artwork to make the master artwork which is too involved to discuss at this time. There are two methods of precoloring—namely silk screening and printing.

Silk Screen Costs are as follows:

Screens $20 to $40/color for ½ sheet 20x25
Screening $.03/color for sheet 20x25
Paints run 7.00 to 12.00/gal. and cost about $.01/sq. ft.

Various types of screens and methods are employed depending on the artwork.

Larger Screens cost more proportionally per color in as much as handling costs mount.

Paints must be selected which have good adhering qualities and will stretch 100% without breaking or changing color appreciably.

Printing requires longer runs to prove economical. Plates run from $75 to $150/color and in general the plastic sheet size is controlled by the printing presses available.

A full sheet of 8 sq. ft. runs about $.04/color on a litho press and requires a run of 7,500 to 10,000 sheets minimum.

Printing inks because of their fast drying requirement do not have the good adhesion of silk screen paint and require an overcoat to prevent the color from rubbing off. They are also sometimes too thin for illuminated products and require double printing to obtain sufficient color depth. Sheets for printing must be cut to accurate size to feed properly in the presses.

FORECAST FOR MACHINE SIZES

Largest now	21 sq. ft.
Designed	28 sq. ft.
Being designed	51 sq. ft.—500 oz. of 31 lbs. per sheet
Next	100 sq. ft.—1000 oz. or 60 lb. sheets

MACHINE FORECAST

No. Machines	injection	7000 to date
No. Machines	vacuum	200 to date
No. Vacuum Machs.	Estimated (can be absorbed)	300/year

SPE PRIZE PAPER CONTEST

For the seventh year, the Society of Plastics is conducting a Prize Paper Contest, with national awards of $200, $100, and $50. The rules are simple.

Anyone may compete. Entries from non-members and from foreign countries are welcomed.

The paper may deal with any phase of the plastics business; materials, molding, extruding, work techniques, chemistry, design, molds, applications, and so on.

The paper must make a real contribution to the plastics industry. The material must be original and not previously published or committeed for publication. Graphs and drawings should be in black ink on white paper or tracing paper. All references must be cited.

All papers submitted become the property of the Society of Plastics Engineers.

Papers should be submitted to the nearest local Section of SPE for first judging; if in doubt, send manuscript directly to Prize Paper Contest, Society of Plastics Engineers, Security Bank Bldg., Athens, Ohio.

Contest closes October first, 1953.

Plastics Engineered for Relief Map Reproduction

John J. Gurtowski

Department of the Army

Presented at the Ninth SPE Conference

DURING THE SECOND World War, three-dimensional maps were used to a great advantage for many types of military operations. Unfortunately, the few available relief maps were made of plaster and of sponge rubber. Whereas sponge rubber models eliminated the disadvantages of plaster, they still required hours of hand painting; consequently, high cost and limited production still remained.

To overcome limited production and high unit cost, the Army Map Service initiated a development program. A new technique has gradually evolved for the mass production of plastic relief maps. Plastic sheets are printed by offset lithography from the same plates used to print paper maps. These flat plastic sheets are then formed, by heat and vacuum, over a plaster mold of the landforms of the area.

This new product is now in considerable demand by the Armed Services for it has proved a valuable aid in teaching map interpretation and unit tactics, and for briefing combat personnel.

The increased military demand for plastic relief maps, plus their probable eventual use in our educational systems, emphasize the importance of evaluating the plastic now employed in relief map production, as well as advancing specifications for improved plastics for this use. From our investigations the resolution of four important problems would help in furthering the progress of relief mapping. These problems are:

1. Lack of uniformity of plastics and plastic inks, and high cost of materials.

2. Lack of plastic sheet materials for use in producing maps for use under special conditions.

3. The need for light weight casting material from which library molds can be made to conserve storage space.

4. The need for inexpensive and more efficient production molds to replace fragile plaster production molds currently used in the vacuum forming process.

The Army Map Service, being primarily a service organization, must look to plastics chemists, plastics engineers, and plastics manufacturers for assistance in solving these problems. Each problem will be presented to you in detail so that you may better understand it, and having this information you may be able to suggest a new or better approach.

PROBLEM #1—Plastic Sheets and Plastic Inks for Relief Maps.

The majority of relief maps being produced are made from commercially available rigid vinyl sheets, opaque-white, 0.015 inches thick, with a matte finish on both sides. This material has been selected because it is dimensionally stable, fire and moisture resistant, durable, easy to form, and retains little plastic memory after forming. In the early stages of plastic relief map production no importance was attached to exact surface and thickness tolerances. Today, based upon an accumulated wealth of plastic sheet performance data, it has been found that we require plastic sheets produced to more rigid tolerances. A plus or minus .001" dimensional tolerance for 0.015" material would be very desirable. Plastic sheets with surface blemishes, flow marks, and imperfect surface conditioning must be eliminated to speed lithographic printing and lessen rejects in forming.

When the plastic sheet manufacturer submits his material for evaluation, it would be advisable to include complete information on the source of compatible plastic inks which can be used in printing by offset lithography. This information should include the basic components of the ink formulation, speed of drying, bond strength, and the flexibility of the thermo-plastic ink film.

Forming tests mean little to the relief map producer if he cannot print successfully on the sample submitted. If he has the necessary information, inks, and plastic sheets can be evaluated simultaneously.

The price of plastic sheets used in relief maps is another problem of major importance to the map producer. Appreciable lowering of the present price per sheet of plastic, currently in excess of 50c per 24" x 36" sheet, will go a long way in increasing the demand for the vacuum formed product.

PROBLEM #2—Plastic Sheets for Special Relief Maps.

Under certain field conditions, the physical properties of the vinyl relief maps are not completely satisfactory. For example, the vinyl sheet loses its flexibility at -25°C, becomes brittle and shatters like glass. A plastic sheet must be developed which will remain flexible at temperatures approaching—40°C, while retaining the other desirable physical properties of vinyl.

At times the bulkiness of the vinyl relief map has also been found inconvenient. Under certain conditions it would be desirable if the relief map could be folded or rolled.

Ethyl cellulose, cellulose acetate butyrate, rubber vinyl, rubber-styrene, plasticized vinyl and synthetic rubber have been tested. None of the materials tested to date has been entirely satisfactory because of one or more of the following deficiencies: low impact and compressive strength, poor tear resistance, flammability, poor dimensional stability, poor ink retention, or high brittle temperature.

PROBLEM #3—Library Molds.

An inherent problem associated with increased production is mold storage. These molds are a major concern because they are made of low-expansion plaster and are very heavy and fragile. The Army Map Service library contains several hundred plaster molds. New molds are produced at the rate of 40 - 50 a month. Each mold is of

varying thickness, 24 inches wide, 36 inches long and weighs approximately 70 pounds. To replace a damaged or broken mold is costly and time consuming.

The heavy weight of these molds, their fragility, and the limited storage space have forced the Army Map Service to search for a new material from which to cast strong, light weight library molds occupying less space. This problem has become even more pressing when consideration is given to producing molds 60 inches long and 40 inches wide.

Filled polyesters, foam and cast phenolics, the amines, the furfurals, sprayed metal, inorganic casting material (such as the lava compounds), the plastisols, and the plastigels have been tested for possible use in making library molds. Each material partially meets the specifications. Not one has been found completely satisfactory. For this reason we look to the plastics industry for assistance. To satisfy our needs any resin, with or without fillers, must meet the following specifications:

1. The maximum dimensional change in the new material must not exceed plus or minus 0.005" per foot of mold when cured.
2. The finished (cured) material must retain its stability when subjected to long storage and normal change in humidity and/or temperature. Warpage in excess of 0.01" ft. cannot be tolerated.
3. The new mold must be light in weight. A mold 1" x 24" x 36" should not weigh more than 15 pounds.
4. The cured resin must withstand a temperature of 300 F.
5. The cured material must have high impact strength to prevent breakage when struck or dropped. To be satisfactory, the impact strength must exceed 10 foot pounds inch Izod, notched.
6. The compressive strength must exceed 5000 pounds per square inch.
7. The resin must be mildew and fungus resistant.
8. It must be fire resistant or fire proof.
9. The new molds must be easily stripped from master plaster models.
10. It must be resistant to acid or alkali decomposition, e.g., the material must not decompose when alkaline plaster is cast over it.

PROBLEM #4—Porous Production Molds.

A thorough investigation of our production techniques indicates that other more efficient materials besides plaster may be used to make production molds. In order to successfully form the heat softened plastic sheet over the mold, many tiny holes are drilled through the plaster for the vacuum action. Eighteen hours of work may be required to drill these holes.

Our ultimate goal is to produce a dimensionally-stable, temperature-resistant porous mold which will eliminate drilling. Study of this problem led us to consider the possibility of using porous sand molds in production. Initial forming experiments with porous sand molds proved successful. However, certain factors must be considered before porous molds can be put into operation. Production molds cannot be made so perfect that no modification or alterations are needed. Plastic sheets vary in thickness, flow, and other physical properties. To compensate for these variations the operator must carve away or build up certain areas of the production mold. The porous sand-resin composition can be carved or built up, but the method is difficult and time consuming.

The Army Map Service looks to private industry for the pertinent information required in the development of porous production molds. To guide industry we submit the following desired properties of such a mold:

1. The maximum change in the cured mold must not exceed plus or minus 0.005 inches per linear foot of mold.
2. The mold must be at least 30% porous to be acceptable for vacuum forming and still retain its high impact and compressive strength.
3. The resin-filler composition must be of such a nature as to permit carving or build-up quickly and cheaply.
4. The production mold must be wear resistant when relief maps are formed over it.
5. The resin-filler composition must withstand 10 second cycles of 300°F heat for an indefinite period.
6. The porous mold must be made over a plaster negative with a minimum of pressure to prevent master mold breakage.
7. Finally, weight is an important factor. The ideal weight for a mold 1" x 24" x 36" should not exceed 50 pounds.

The relief map producer realizes his needs are, for the most part, unique to the plastics industry and the materials used are only a small fraction of the yearly plastics output, but resolution of the problems presented herein should result in greater demands for plastic materials for relief maps and other vacuum formed products. The Army Map Service earnestly solicits any suggestions and will be pleased to test materials submitted for relief map application.

It's Here! The New

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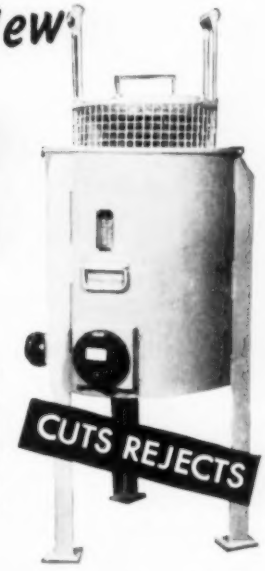

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By A. R. Morse

President, Injection Molder's Supply Co.

The Frozen Man

High on the northern slopes of Mt. Everest, in an unmarked crevasse lies the body of Maurice Wilson. For a change, let us take a moment from our work to hear about the world's most fantastic adventure — the true story of a man who tried to conquer Chomo Lugma, "Goddess Mother of the World" all by himself!

Wilson was a shy, retiring, peculiar boy. He undoubtedly read of the Everest Expeditions of 1921, 1922, and 1924. Somehow the idea of Everest got fixed in his mind, and he gradually became a soul tranfused with holy purpose. It is said that he learned to play the piano and sing, imitating Caruso — from recordings — with remarkable gusto. He worked in movie houses, I heard, in the days before sound, to earn enough money to carry out his objective. However, he knew nothing about mountaineering, so he conceived the idea of flying a plane as high as he could on the shoulder of Mt. Everest, crash-landing it, and proceeding to the summit on foot! To this end, he actually learned to fly, bought a small plane, and finally flew out to India, where the authorities at Purnea eventually confiscated his ship.

Some say Wilson was a fanatic, that he had a wild theory about fasting whereby after three weeks a man could break through the barrier at the borderline of consciousness, so that the physical mind could tap the unbounded energy of the human soul! With this increased physical and spiritual strength, superhuman accomplishments became possible. Some say Wilson sought publicity for his divine theory by his mad attempt on Everest.

He managed to hire 3 Sherpas from the 1933 Everest Expedition. He paid his rent for 6 months in advance in Darjeeling, and said he was going tiger hunting with friends to mislead the authorities. By travelling in disguise and in secret he was smuggled by the Sherpas through Sikkim and into Tibet, where they finally reached the Rongbuk Monastery at the northern foot of Mt. Everest. He made a tremendous impression on the abbot of the monastery, as indeed he did on all who came in contact with him, and who were somehow persuaded to help him on his consuming mission. His whole being was suffused and transformed with his holy purpose — to reach the summit of the world's highest mountain!

He managed to get a few supplies at the monastery, and set out up the rugged Rongbuk Glacier. He planned to subsist on rice water and on a few fruit cakes which he carried, and to reach the summit in 4 to 5 days. At the head of the glacier he was driven down by a spring blizzard. Two weeks later in a lull in the spring gales, he started out again. This time the Sherpas went with him as far as Camp III, and there they showed him a food cache left the previous year by the 1933 Expedition. They felt he was inadequately equipped to go on, and would not accompany him farther. Day after day he set out, attacking the massive ice cliffs, and trying to make his way up to the North Col — the only feasible way to the summit. Finally the Sherpas deserted him. Though he now had ample food, the mountain slowly took its toll of him. He gradually weakened under the combined effects of cold, altitude, and exhaustion, but still he clung steadfastly to his divine purpose. The last entry of the 37 year old adventurer in his dairy was on the 31st of May, 1934.

When the expedition of 1935 was passing the site of former Camp III, Eric Shipton came upon a weird figure, sitting alone in an eerie world of wind and ice. It was Maurice Wilson, frozen, still staring at the rocks and snows of Chomo Lungma! His tent was completely blown away, only the guy lines attached to boulders still remaining, and they buried him in a crevasse nearby.

I have heard that his camera was found, and when the films in it were developed, one of the photos was of himself, apparently taken by one of the Sherpas before they abandoned him. A man who knew him as a youth and young man told me he saw this picture of Wilson, and that it was the picture of a new man, a man reborn, and lifted to the supernal heights of strength, power, insight and vision by human dedication to a superhuman objective.

In these days when the individual counts for less and less, I sometimes think of Maurice Wilson alone in his icy grave.

Next month: Causes of heating cylinder failure.

S P E PRIZE PAPER CONTEST

See page 27 for details

Industrial Literature

We wish to announce the release of a Materials Handling Equipment Reference Chart describing our full line of materials handling equipment.

The chart is prepared in a handy to use form suitable for either wall mounting or folding to 8½ x 11 for easy filing.

For quick reference its 50 illustrations of materials handling equipment are classified into the categories of "Package Handling," "Bulk Handling," "Roller & Wheel Conveyor," "Monorail," "Storage Equipment," "Power and Hand Trucks," "Truck Accessories," "Cranes and Hoists" and "Chain & Cable Conveyors."

Production men, purchasing agents, executives and engineers will find it extremely useful when considering materials handling problems.

This chart will be mailed free of charge to your readers upon request. A copy is enclosed for your reference.

Tumb-L-Matic, Inc., New York, N. Y. offers a new bulletin on its line of Multiple Unit tumbling barrels for high-production deburring, cutting, and finishing of small plastic, and metal parts.

The bulletin explains how several barrels mounted on one frame are driven by one motor and how any one barrel may be stopped for emptying or filling without interrupting the operation of the others. It gives information on drive, sizes, and types and includes pictures of horizontally-mounted and vertically-mounted models.

For copies of Bulletin MP-52 write to Tumb-L-Matic, Inc., 4510 Bullard Ave., New York 70, N. Y.

"Finish Plastic Molds In Minutes" is the title of a new 4-page bulletin just published by American Wheelabrator & Equipment Corporation, 1258 South Byrkit Street, Mishawaka, Indiana, on the subject of wet blasting plastic molds.

This illustrated brochure shows how wet blasting is used both in the original manufacture of molds and in their reconditioning maintenance to bring about important savings of time and labor, and reduce manual polishing requirements. Wet blasting during manufacture of a mold blends all grinding lines, tool marks, and surface imperfections and removes heat treat scale. During reconditioning, it is done to remove the carbonaceous deposits which form and the plastic resins which adhere to the mold surfaces.

Free copies may be obtained from American Wheelabrator. Ask for Bulletin 63.

A radically new adhesive, POLY-GRIP has been developed by Adhesive Products Corporation, 1660 Boone Avenue, New York 60, New York.

POLY-GRIP makes it possible for the first time to adhere ordinary paper labels to polyethylene squeeze bottles and polyethylene containers. Conventional adhesives used for labeling will not adhere to polyethylene. For this reason, until now, squeeze bottles have been stenciled or silk-screened, a process which is considerably more expensive than labeling.

The introduction of POLY-GRIP Polyethylene Adhesive should result in more powerful and attractive packaging for polyethylene packaged items. POLY-GRIP is easily applied by conventional labeling machines.

Carl E. Schmitz has recently been appointed Vice President in Charge of Sales for Crane Packing Company, Chicago, Ill., a leading manufacturer of mechanical packing, mechanical seals, Teflon parts, Lapping machines and other products. He formerly held the position of Vice President and Director of Engineering.

International Glass Corp. has recently purchased all the plant facilities and equipment of the Perrault Glass Fiber Corp. in Newport, Arkansas for over five years one of the world's two largest manufacturers of glass wrap for the oil industry. The new acquisition, plus the Los Angeles Company's other plants in Puente and South Gate, California, will place International Glass among the Country's foremost glass fiber and several manufacturers. Executive offices and research laboratories of the Company are located at 8715 West Third Street, Los Angeles, California.

AROUND THE WORLD

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AUSTRALIA

AUSTRALIAN PLASTICS

Vol. 8, No. 89, December 1952

Abstracter: Albert Lightbody

PLASTICS AS A STRUCTURAL MATERIAL (Some notes from American Society of the Plastics Industry which covers the emergence of reinforced plastics as a structural material.)

Various applications and advantages for reinforced plastics give an idea of the large extent to which these materials are being tried.

STYRON GENERAL DESIGN PROBLEMS (Reprint from "Dow Digest")

The design of polystyrene items is discussed giving consideration to wall thickness, ribs and bosses.

PLASTICS IN THE TEXTILE INDUSTRY by Alan Beecham (Reprinted from British Plastics)

Courtaulds Limited at Coventry, a pioneer in this field, have found the need for accurate surfaces, using phenolic resins almost exclusively. Spinning boxes, bobbins, bevel gears, etc. are the principal products. Careful balancing is required as speeds up to 10,000 rpm are used.

PLASTICS REPORT FROM BRITAIN

There has been some general contraction in plastics business in Britain but some companies are starting to handle silicones. New products include a p.v.c. tubing with a helical steel wire reinforcement to withstand 150 psi; U.F. plastic button blanks and a new plasticizer (polypropylene adipate) for vinyl resins. New processes include a special silver spraying process for coating plastics and paper; and an interesting method for producing a fabric finish on plastics. The fibers are deposited vertically, giving a deep "pile" by attracting the fibers electrostatically to the adhesive coated plastic.

EXPANSION IN AUSTRALIAN BASIC INDUSTRY

The Division of Industrial Development has recently prepared a document giving information on existing manufacturing industries in Australia. Increases in production of coal of 35% over 1951 and 1.76 million tons of pig iron to 2.61 million tons. Rolling and processing of steel are being increased, to be completed in 1955. A seven-fold increase in oil refining is planned by 1956. Basic chemicals and paper production expansions are underway in similar proportions.

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DENMARK

PLASTIC

Vol. 2, No. 11, 1952

Abstracter: Erik R. Nielsen

HOW TO AVOID BUBBLES AND SURFACE DEFECTS IN INJECTION MOLDING by Fritz Schaupp

Internal bubbles and surface defects are not caused by entrained air, as often stated; instead they are due to contraction of the solidifying material and occur when insufficient material is fed to the mold during the solidification. The remedy is to increase the dwell, enlarge gates and runners, or increase the injection pressure. Each remedy is discussed.

PVC-CONSUMPTION AND POTENTIAL IN USA

Discussion by W. A. Mitchell, B. F. Goodrich Chemical Co. The 1957 consumption is estimated to be 800 million lbs. (or double the present consumption), with a major expansion in the fields of floor tile and pipe.

CELLULOID

Review of the properties, preparation, fabrication, and applications of celluloid.

DRY-COLORING OF POLYSTYRENE by Sanford E. Glick

Part 1 of a discussion of the dry-coloring of polystyrene.

Vol. 2, No. 12, 1952

PROPER PROCESSING OF POLYSTYRENE: Anton Schmidt

Detailed discussion of injection molding of polystyrene: storage of molding materials, injection temperature, mold design, and molding cycle.

HOBBING OF MOLD CAVITIES (ALLOY STEEL): John L. Sekowski

Discussion of the production of cavities by the hobbing process, and of the alloy steels used.

DRY-COLORING OF POLYSTYRENE: Sanford E. Glick

Second part of a detailed discussion of the dry-coloring of polystyrene.

Vol. 3, No. 1, January 1953

THE PROPER USE OF PLASTICS by G. Terp

The choice of a plastic for a particular use must be based on the physical, electrical, and chemical properties of the plastic. This point is illustrated by examples.

REPORTS FROM ABROAD. THE PLASTICS INDUSTRY IN INDIA

About 200 compression molding machines, 400 injection-molding machines, and 50 extruders are in operation in India. Two plants produce phenolic molding powders, but polystyrene which is in demand, must be imported (benzene and ethylene are available for potential production). Laminates and films are not produced.

INDIAN PLASTICS DIRECTORY. 1952. (Published by Plastics Machinery Distributors, 4, Upper Chitpur Road, Calcutta, India)

This directory gives names, addresses, and information on societies, molders and distributors.

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INDUSTRIE DES PLASTIQUES MODERNES

Vol. 5, No. 2, February 1953

Abstracter: Hans Mayer

IRRIGATION

Plastic hose, tubing, and fittings have become a major tool in the irrigation of agricultural projects.

FLUORETHYLENE PRODUCTS

The origin of this family of plastics is described, differences in the formulation of the major brands (Teflon, Kel-F, Veloform, Fluon) are being discussed and present and future potential applications are analyzed.

A NEW TYPE OF HERMETICAL CLOSURE by F. Criqui

Thermoplastic molded containers and lids of special rim design and equipped with a rubber gasket can be sealed hermetically by means of a patented apparatus which exercises pressure and welding heat at the same time. This method lends itself to the packing of food and the time required for each sealing operation is about five seconds. The contents can be pasteurized without breaking the seal.

POLYESTER FILM

DuPont's product Mylar is discussed.

PLASTIC STEREOTYPE — (second article of a series)—**Paul Royer**

Describes methods and materials used to make stereotypes from plastic materials or from paper pulp and additions of synthetic resins.

POLYVINYL BELTS FOR SMALL MACHINES — A. Ramaud and R. Brouillet

Belts made from this material can be used advantageously for light drives like sewing machines and small machine tools. They can be joined without seam, the necessary stability can be accomplished by stretching the material before it is made into the belt.

THE COOLING OF MOLDS—H. Spies

The cooling of molds by water, air, and a combination of water and air is discussed.

PRESSURE NEEDS OF AN INJECTION MACHINE—H. Gastrow

Reprint of an article in Kunststoffe, vol. 42, 1952.

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GERMANY

KUNSTSTOFFE

December 1952

Abstracter: Anne Schwend

The following articles represent addresses held at the German Plastics Industry's Convention in Duesseldorf in October 1952.

Dr. Richard Roehm—Introductory address outlining aims and reasons for holding the convention.

Dr. Arttur Straeter, Duesseldorf, Economics Minister in North-Rhine-Westfalia

A short review of the economic and financial situation of North-Rhine-Westfalia.

Dr. G. Seeliger, Economic Ministry, Bonn

A survey of the problems the German industry and thus the plastics industry are confronted with. Pacification of the world market, a certain saturation of German import requirements, loss of the Eastern markets, liquidation of German foreign debts and many other problems make it necessary to continue in Germany's efforts in order to retain the rather favourable position acquired and to strengthen the economic ties resumed in order to guarantee an adequate standard of living.

Dr. Herbert Gross, Duesseldorf — Characteristical Picture of the Modern Employer

Neither outspoken specialization of the undertakers, nor facilitation of working conditions offered the workers through rationalization and mechanization, nor generous care for the welfare of the employees, nor nationalization have had the desired effect. The answer is always the same: disatisfaction, demands for higher wages and criticism of welfare and social politics. Employees and manual workers in particular are mainly guided by the following five desires: good and just wages, economic and social security, possibility for advancement, humane treatment and recognition, furtherance of the creative powers in the individual. This necessitates a new division of responsibilities in a plant which does not restrict the functions of the undertakers to the head but distributes them over a long chain of ranks in which especially the task of the workshop managers is of utmost importance in that they are bound to continually mediate the information about what is going on in the plant to all subordinates and thus make all workers equally valuable and important partners in the society, which forms the basis for inner satisfaction, personal advancement and maximum financial remuneration. —A very interesting article by a well-known German publisher.

Prof. Dr. Heinrich Hopff, Badische Anilin- und Sodafabriken, Ludwigshafen—Thermal Reduction of Macromolecular Compounds

Familiarity with the decomposition products resulting from thermal reduction is of great importance for any molder of plastic materials, especially in case noxious or corroding substances develop during this process. With the help of numerous diagrams and numerical surveys the author publishes the results of tests made with the most important macromolecular compounds such as polyethylene, polyisobutylene, polystyrene, vinyl and acrylic resins, polycondensates and acetylcellulose.

Prof. Dr. O. Bayer, Leverkusen — Synthesis Principles of the Net Structure of Macromolecules

This address mainly dealt with modern interlacing agents to which the Farbenfabriken Bayer at Leverkusen have contributed some valuable agents.

Gerry P. Mack, New York — Theory and Practice in Stabilizing Vinyl Compounds in the United States

This address will be copied in a later edition and will mainly show the effect of stabilizers containing organic tin compositions.

Prof. Dr. Ing. Rudolf Nitsche, Berlin-Dahlem — Some Points Regarding Testing of Plastic Materials

In order to give any designer of plastic molds reliable information on the reactions of plastic materials in practice and thus facilitate his work, a comprehensive knowledge of the chemical composition, structure, physical properties dependent on time, temperature and all other conditions surrounding the specimen to be tested, is required. The author gives a survey of testing methods developed and standardized so far. Very few of the existing plastic materials fulfill the basic requirements of isotropy and freedom from strain which would allow to set up "material constants." A number of examples demonstrates the inperspicuity of orientation and strain in test specimen. Data about the symmetry in the formation of certain order stages upon molding and the coherent properties will have to be worked out with all speed.

Dr. A. V. Blom, Locarno — Context between Macromolecular Structure and Mechanical Properties of Deformational Character

The development of new plastic materials with predetermined properties will only be possible if it is known which structural properties cause certain strengths. The structural principles of organic plastics as a reason for their mechanical properties, under particular consideration of the biphase theorem, are investigated.

Prof. Dr. A. Peterlin, Ljubljana Jugoslavia — The Viscous Reaction of High Polymers and Polyelectrolytes

The viscosity of high polymer systems is highly dependent on temperature, pressure and shear stress at constant compositions. Since the viscosity of a polymer chain increases considerably with the molecular weight, it can be used for the determination of the molecular weight. In diluted solutions the viscosity values directly indicate the conduct of the individual molecule. With most of the high polymers, especially the polyelectrolytes, the form of the molecular conglomeration is determined to a large extent by the interaction with the solvent.

Dr. Franz Wuerstlin and Hermann Klein — The Plastification of Macromolecules (A report from the laboratories of the Badische Anilin- und Sodafabrik, Ludwigshafen)

The problem of exterior plastification of macromolecules is being dealt

with from a scientific standpoint. The examples cited demonstrate the dependence of plasticizer properties on the chemical constitution of the plasticizer. The overall plastification problem is being sub-divided into effectiveness of plasticizers and interaction between plasticizer and macromolecular substance. Both of them are highly dependent on the chemical constitution, however, in an opposite sense.

Dipl. Ing. **Peter Hoppe, Leverkusen—Expanded Plastics and their Utilization**

After a brief introduction into the technique of production of expanded plastics, present and future needs are explained. Intensive tests will aim at the increase of specific strength. For molded products or those materials receiving a cover layer, the specific weight shall increase from the core towards the surface in order to come closer to the ideal structure as existent in bones or the elder trunk. Current research work shall reduce the unit weight of the cellular bodies. Addition of fillers and their influence on the λ-values will have to be studied closely. Fillers like Santogel and Siligel would be advantageous if the pore sizes were chosen not higher than 1 mm. Non-flammability, resistance against termites and the development of better binders on polyester basis, free from solvents, in addition to greater economy are further demanded. A survey on forms of application, also in combination with other materials follows.

Dr. Ing. **W. Woebcken, Bonn — Influence of the Kind of Processing on the Strength of Transfer Molded Parts**

Upon processing of thermosetting compounds decomposition and orientation cause differences in strength and shrinkage. The danger of decomposition can be confined through appropriate design of molds and proper processing. The orientation of filler particles affects anisotropy as regards thermal and mechanical reaction. The author discusses cause and effect of orientation in U-shaped profiles. In case the designer is unable to avoid orientation through appropriate shape, the designer of the tools will have to evade the effects through ingenious location of the sprues or choice of a compound and processing method answering the requirements. High quality articles may be obtained through close collaboration between designers, constructors of tools, processors and controllers. However, further progress in processing methods will only be achieved if one of the primary demands: molding compounds of isotropic and homogeneous properties, will be fulfilled.

Dr. Ing. **H. Klingehoeffer, Muenchen —Plastics for the Wrapping of Foodstuff**

A juxtaposition of technical demands and the possibilities given the plastics industry for wrapping foodstuff. Progress may particularly be expected from the development of combined plastics under utilization of paper and metal foils and proper lacquers as well as binders.

Editorial

A resume of the impressions gained from the Plastics Convention and Exhibition in Duesseldorf held in October 1952, and a reprint of opening addresses held.

Dr. Gerhard Beck, Wuppertal-Elberfeld, and Dr. Albrecht Rosenberg, Marl —Migration of Plasticizers, Damages Done and Remedies

The essence of the migration of plasticizers is discussed as well as the use of polymer gelatinizers and lacquers. A new proposal for measuring the amount of migrated plasticizer is put for discussion.

A nitro-cellulose film of certain thickness was put into contact with a plasticized PVC film, was weighed and kept under specific load at a temperature of 70°C (158°F) for several days. The loss in substance was very low at this temperature and was further reduced by putting glass plates on the films. The amount of migrated plasticizer could well be stated after 4 to 5 days, results are laid down in two numerical tables. To broaden the test basis, two different PVC films were used, one having an equal share in units of weight in both PVC and plasticizer, the other having 70 units of weight in PVC and 30 units of weight in plasticizer.

These tests have helped the authors in their endeavours to find soft PVC compounds with little or no tendency for migration of the plasticizer content.

H. Tischer, Freiburg Br.—"Celodal" a Plastic Material for the Preservation of Biological Objects

"Celodal," a product of the Badische Anilin- und Sodafabriken at Ludwigshafen, a urea-formaldehyde-condensate, is used for the preservation of objects of scientific value. Maintenance of the water content of Celodal requires that it be kept under glass cover. This condensate is absolutely clear and colorless and objects thus preserved may be used even in a projector. Instructions for casting the resin are given.

Processing of Polytetrafluorethylene (Teflon)

The processing methods for Teflon, as developed in the Du Pont Laboratories and published by J. F. Lontz and W. R. Happoldt jr. in Ind. Engng. Chem., volume 44, 1952, pages 1800-05 and 1905-10, are summarized since this product will now also appear on the German market.

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DER PLASTVERARBEITER

Vol. 4, No. 1, January 1953

Abstracter: E. C. Bernhardt

PLASTICS IN THE BUILDING INDUSTRY—Illuminated Signs of Plexiglas—by H. Schmidbauer

Description of standard methods for forming letters from acrylic sheet stock.

RECOMMENDATIONS FOR THE INJECTION MOLDING OF "PLEXIGUM" by E. Messalla

Instructions for the successful molding of "Plexigum," an acrylic acid ester.

CURRICULUM FOR PLASTICS PROCESSING

A brief note calling attention to the special course in welding, glueing, forming and machining of plastic materials offered by a trade school. This course is to be followed by a second one in techniques of lining vessels with plastic materials.

MALE AND FEMALE THREADS ON INJECTION MOLDED PARTS by Spies

Sketches and descriptions of methods for molding threaded objects such as caps for tubes and bottles.

CENTERING OF WIRE INSERTS IN THE TEMPLES OF EYE GLASS FRAMES by Spies

The wire insert is held in the center of the mold cavity by two small brass bushings. As the cellulose acetate is injected and flows along the cavity, it carries the bushings along, and pushes them off the end of the wire.

CAPACITIES OF HIGH FREQUENCY WELDING EQUIPMENT by L. Rausch

Welding units are commonly rated according to welding area. Variables which influence the capacity are discussed. Effects of material to be welded, gauge of the film, time of exposure, and shape of the electrodes are illustrated.

PROGRESS IN HIGH FREQUENCY WELDING OF PLASTICS by J. Brandenburger

Review of techniques used in bonding of fabrics to PVC, welding of polyamide belting, welding of cellulose acetate film, and welding of woven Saran. An endless abrasive belt is glued together with an adhesive which is cured by high frequency.

PRODUCTION OF MOLDED PARTS CONTAINING THREADED HOLES IN THEIR SIDES by K. Brandenburger

Sketches of good and bad practice,

and rules for properly molding threaded objects.

STUDIES ON THE CONSTRUCTION OF A MOLD FOR BICYCLE HANDLES by A. Urbanz

Illustration of various modifications carried out on a mold in order to improve its operation.

MOLDING OF HOLES IN HINGES

A piano wire is positioned in the mold where the holes are to be located. This wire extends to the outside of the mold, and is pulled out before the shot is completely cooled. It is claimed that satisfactory pieces are produced in this way.

REDUCTIONS IN THE COSTS OF MOLD CONSTRUCTION

A system for casting alloy steel molds is described. The technique is similar to Beryllium Copper casting. The alloy steel is heated by high frequency in a vacuum.

APPLICATIONS AND PROCESSING OF CELLULOID by R. P. Sondermann

Review of specifications of various grades of Celluloid. Discussion of application problems.

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GREAT BRITAIN

BRITISH PLASTICS

February 1953

Abstracter: Herbert R. Simonds

EDITORIAL: (1 page)

Packaging in Plastics

The importance of packaging in the plastics industry is pointed out with the statement that the turnover in packaging in England is now about £300,000,000. "How much of this can be credited to plastics is anyone's guess, but in the highly packaging-conscious U.S.A. about 25% of the plastics industry is devoted to packaging uses."

SHEET PLASTICS USED BY PACKAGING INDUSTRY
(6 pgs. illustrated)

Polyvinylchloride as a packaging material has extensive possibilities, but to reach maximum efficiency, sheeting of this material must be adjusted in composition to the work required. The Greenwich Leathercloth Co., Ltd. produces ten standard grades of p.v.c. film for packaging. Polyethylene and cellulose acetate are also important packaging materials. Polyethylene though is more expensive than p.v.c., but has the advantage that it is available in thinner gauges. Films of this material 0.0015 in. thick are in common use. Polyethylene packaging may be easily assembled with heat sealing equipment. Several types of heat sealing devices are described. Polyethylene is also used as a coating material for other materials such as paper or foil. When polyethylene is sandwiched between two layers of kraft paper, the laminate offers great strength and may be used for packaging such products as cements, fertilizers and ion exchange resins. Formerly, polyethylene was applied to the paper by a hot dough spreading technic. Now, a combination extrusion-calender process feeds the paper to a nip between a water cooled chromium plated roll and a rubber covered roll. Polyethylene is extruded at about 600°F as a hot molten film and this strikes the paper immediately before it enters the nip.

MANUFACTURE OF LARGE SYNTHETIC RESIN-BONDED PAPER TUBES FOR THE ELECTRICAL INDUSTRY (4 pgs. illustrated)

Unusually large insulating rolls for transformers and other electrical uses are made by coating paper and then winding many layers on a mandrel to form the tube. The paper is first passed through a resin-impregnating machine which is approximately 60 ft. long and 20 ft. wide and 14 ft. high. The resin used is cresol formaldehyde and is applied as a varnish dissolved in alcohol. The process is carried out at room temperature, with the varnish kept circulating to assure uniformity. From the impregnating plant the paper passes to an oven where the alcohol is evaporated, leaving the resin coating dry, but largely uncured. The tubes are made by passing the paper over roller heaters and then winding it on a mandrel of the size desired. A parting layer prevents adherence of the coated paper to the mandrel.

BRITISH PLASTICS CONVENTION 1953 (2 pages)

This is to be held at Olympia, June 8-18 and a full list of papers is given. Noteworthy among these are the following: (1) Recent commercial developments in melamine and guanamine resins, (2) Molded and extruded polyamides and polyesters, (3) Silicones in the plastics industry, (4) Surface chemistry and adhesion of glass and plastics, (5) Some considerations in the design and manufacture of structures in glass reinforced plastics, (6) Plastics in the toy industry, (7) The metallization of plastics by vacuum evaporation for functional and scientific purposes, (8) Flame-proof conveyor belting.

DESIGN FEATURES IN NEW PORTABLE RADIO
(1 page illustrated)

A portable machine is shown and described. One of the features is water-proofness so that it may be used outdoors.

PLASTICS PIPING FOR LIQUID HANDLING (5 pages illustrated)

Polyethylene pipe is being rapidly developed as a means of transporting cold water. An idea of the importance of cold water pipe for agricultural purposes is in the fact that the estimate of the piping required totals 100,000 miles. A comparison of different materials for piping of this character is as follows:

Cost per ft., 1 in. Diameter Pipe

Galvanized steel		10 d.
Polythene	1s.	5 d.
Copper	2s.	3 d.
Lead alloy	6s.	5 d.
Lead	7s.	7 d.

Both rigid and flexible p.v.c. pipes are now being produced in the United Kingdom. This is important because of the ease of fabricating. For small diameters, the extruded tubing can be taken off the shelf and formed into bends and coils as required. Other types of plastics pipe now used in the United Kingdom include cellulose acetate, butyrate, phenolics and ureas.

PLASTICS APPLICATIONS
(4 pages illustrated)

Among the new items listed this month are the following: (1) Molded serving tray, (2) Polystyrene capacitors, (3) A rigid p.v.c. drip tray and down spout, (4) Facia panel molds in the automotive trade, (5) A new type of polythene stoppers to replace corks, (6) Sculptured animals, (7) Rigid p.v.c. cooling coils for handling brine solutions.

SHELL — MOLDING MACHINE STEPS UP FOUNDRY PRODUCTION (2 pages illustrated)

An automatic self-molding machine for production of shell molds for metal foundry use is illustrated and described.

MOLDING AND EXTRUDING FOR ELECTRIC BLANKETS
(3 pages illustrated)

The resistance wire for electric blankets is in fine gauge which is coiled helically around a rayon core and the whole unit is sheathed in a p.v.c. or a polythene coating. The covering is extruded on to the wire helix by a $1\frac{1}{2}$-in. extrusion machine. This extruder is described in considerable detail. It is built by the Warm Glow Co. Ltd. which is the manufacturer of the electric blankets.

TRADE NOTES AND NEWS

In the year 1953 estimates place total production of plastics in the United States at over 2,800,000,000 lbs. with the value at approximately $1,485,000,000.

Shell Chemicals Ltd. announces a reduction in the price of acetone to £143 per ton.

What is claimed as the world's fastest plastics calender with rolls 92 in. wide and 32 in. in diameter produces 120 miles of coating film 6 ft. wide in 24 hrs.

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PLASTICS
January 1953
Abstracter: A. T. Rexer

PLASTICS IN THE SERVICE OF MAN

A pictorial review of high-quality units molded or otherwise fabricated in Great Britain for use in the food industry.

MACHINERY AT THE GERMAN PLASTICS EXHIBITION

This article gives condensed information on the various types of German plastics machinery which were exhibited at Dusseldorf.

INDUCTION HEATING FOR SYNTHETIC RESIN PLANT
by O. Lenhard

A description of the application of induction heating in the production of gauge-oils, esters, and synthetic resins. The advantages of induction heating are especially valuable with large output at temperatures ranging from 100 degrees C. to 600 degrees C. Its economy and ease of operation insure that this form of heating will take a prominent place in the synthetic resin industry.

PRODUCTION OF GLASS FIBRE PREFORMS AT ASHDOWNS, LTD.

A description of the work of Ashdowns, Ltd., one of the largest molding concerns in England, in the field of reinforced glass fibres with special attention to the operation of a Turner Atherton preforming machine. This machine operates on a modification of the process principles which have been in use in the felt hat industry. It consists basically of a closed chamber below which is a powerful suction fan which draws air thru a duct at the top of the chamber down thru a screen placed at the bottom. The screen, which is made of perforated metal, is in the form of the preform to be produced. Suitable short lengths of glass roving, cut by an automatic cutter are sucked thru the chamber onto the screen for a predetermined time; the cycle is electrically controlled. The preform is sprayed with a binding emulsion and then baked in a special hot air oven to prevent disintegrating on handling. When cool they are in a condition to be handled for the subsequent molding operation. In addition, the article describes the production of rods, tubes, and other structures by the well-known processes of winding, laying, and forming. It is well illustrated.

CELLULOSE ACETATE BUTYRATE
by E. E. Halls

The second part of an article comparing cellulose acetate and cellulose acetate butyrate. This part compares these materials in the form of sheets and tubes, most of the data being in tabular form.

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HOLLAND
PLASTICA
Vol. 6, No. 2, February 1953
Abstracter: W. P. ter Horst

PLASTIC FOAM: J. H. Gisolf.

Two types of plastic foams can be discerned viz "low-pressure" — and "high-pressure" foams, depending whether the expansion of the material chiefly proceeded in the liquid—or in a more or less rigid state. The "high-pressure" foams, such as cellular polyvinyl chloride, consist of closed polyedric cells. The structure of the "low-pressure" foams can in most cases be described as a mesh-work of bars with very thin films between them. In these foams many of the cells are open.

Some typical applications of "low-pressure" foams are cushions and mattresses. The "high-pressure" foams are pre-eminently suitable for watertight thermal insulations and for all kind of floating articles.

A description is given of the different groups of polyester-resins, many of which are known as alkyds, and their uses. The importance of the polyester resins among the macromolecular substances is emphasized. The rapid development of the unsaturated polyesters as compared to the different saturated types is stressed.

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UNITED STATES
ELECTRICAL MANUFACTURING
February 1953
Abstracter: Gerald Eisner

SHOCK RESISTANCE

Members of the Naval Material Laboratory and the Bureau of Ships describe an independent series of tests made on a new shock machine. This article contains a description of a machine which tests flexural shock, tensile shock and shear shock of molded thermosetting plastics, and a chart of comparative values is given for some of the phenolics tested.

SWITCH GEAR PARTS FROM GLASS POLYESTER

This article describes the use of glass-reinforced polyester laminate parts to replace canvas-based phenolic laminates in switch gear equipment. The main parting link, stop block, and indicator switch lever were changed for such reasons as superior impact and flexural strength, superior arc resistance and moist resistance, better dimensional stability, less weight and size and lower cost.

VINYL INSULATED COMMUNICATION CABLE

A new Spiral-4 communication cable featuring an extruded vinyl chart for abrasion resistance, light weight and easy handling is described in this article.

Write, wire or phone for new brochure.

50 FT. SPRINKLER
WEIGHS 1 POUND!

This flexible plastic sprinkler can spray an area 15 ft. wide by 50 ft. long at average water pressure. Drape it over your hillside, twine it around your flower beds, shape it to any contour of your landscape—it'll do a perfect sprinkling job in any position! This durable sprinkler will not rot or mildew, even if stored wet! The spray is so fine it's gentle on flowers—a real water saver! Turn the valve and it becomes a soaker. Complete with brass connector. 5 yr. guarantee

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5 YEAR GUARANTEE

SECTION NEWS

Edited by
Stanley Bindman
Jamison Plastic Corp.
71 E. Sunrise Highway
Freeport, New York.

Toledo Section Hears Talk On KEL-F, Has Discussion On Reinforced Plastics

The Toledo Section's March meeting, held on the 18th of the month, featured a talk on "High Temperature Molding Materials—KEL-F" by Mr. S. W. Jones of the M. W. Kellogg Company, Jersey City, New Jersey.

Mr. Jones discussed the availability of KEL-F (polytrifluorochloroethylene) 270, a material having a density of 19 pounds per cubic foot, and KEL-F 300, a material having a density of 60 pounds per cubic foot, the former being a light oil, and the latter being a heavy material.

KEL-F is significant for its temperature resistance and for its high dielectric strength. However, its cost ($12.00 per pound in ton lots) limits its use to special applications. The material was first developed by the atomic energy commission for an undisclosed use.

Mr. Robert Dunham made an oral report to the Section on the recent National Meeting in Boston.

Mr. Arthur Giesler is being transferred by Electric Autolite Company from Toledo to Buffalo.

The June issue of **Toledo Technical Topics,** a Toledo publication issued by a council composed of members of various technical organizations, will be devoted to the plastics industry. The Toledo section of SPE has agreed to supply two essays on plastics for this issue.

February Meeting

The February meeting of the Toledo Section was held on the 25th of the month, and featured a discussion of reinforced plastics by a panel composed of Dr. Russel Plumber of Glass Fibers, Inc., Waterville, Ohio, Mr. Ray Greene of Ray Greene & Company, Toledo, Ohio, and R. S. Morrison of Molded Resin Fibers Company, Ashtabula, Ohio, Mr. Jack M. Little, of J. D. Little & Associates, Toledo, Ohio, an industrial designer, acted as moderator.

Dr. Plumber discussed the history of glass fibers and placed particular emphasis on the importance of the sizing material used on the individual fibers in connection with future developments concerning the production of reinforced plastic materials.

Mr. Greene explained his operation which is concerned with the hand fabrication on inexpensive plaster molds of various objects, principally reinforced resin boats.

Mr. Morrison discussed the molding of reinforced resin parts in permanent molds and difficulties involved in such an operation and their relationship to the possible future of the reinforced plastics field.

Mr. Morrison mentioned that special preforming equipment is required, as well as special molding equipment of a size extremely large for the plastics industry. Post forming, sharp curves, undercuts, and moving mold parts are not at present possible in such fabrication of reinforced resins. Specifically in connection with the automotive field Mr. Morrison estimated that his mold and set up costs for the production of reinforced resin automotive bodies probably would run approximately 10 per cent of the cost for dies and set up for the production of similar parts from metal, while the cost of molds and set up for such production from reinforced resins in single use plaster molds (Mr. Greene's technique) would be perhaps 10 per cent of his cost. However, for manual production the labor cost would be extremely high, for permanent mold production the labor cost would be intermediate, and for fabrication from metal the labor cost would be extremely low. Accordingly, if a few automotive bodies of a given design are to be produced, for example in the sports car field, fabrication on single use molds is probably economically advantageous. However, if a relatively large number, for example several hundred thousand, are to be produced, permanent molding is probably indicated. However, if, as **is usually the case, several million bodies are to be produced, the reinforced resins cannot at present compete with the stamped metal bodies.**

After a relatively extended question and answer period the meeting was adjourned, and a buffet supper was served.

Mold Construction Responsibility at Western New England

E. J. Sweeney

The subject of the March 4 meeting of the Western New England Section was a panel discussion on "Mold Construction Responsibility."

The panel members were Mr. Paul Carroll, who spoke on the molder's problem; Mr. Al Landall of General Electric, who discussed the contribution that the material supplier could make; and Jack Cavanaugh of Standard Tool, who discussed the mold builder's viewpoint. Mr. W. Bentley, Program Chairman of the Western New England Section, acted as the Moderator of the panel.

Mr. Carroll opened the program, reading a typical sales contract that had been set up by a mold maker to cover a mold being built. There were 11 separate points in the contract and each of the speakers covered those points that they were in disagreement with. Mr. Carroll, to start off the discussion, felt that the contract was much too easy on the mold maker, and specifically felt that all jigs and patterns should be the sole property of the molder. Of course, Mr. Cavanaugh disagreed with this point, adding to the interest of the discussion. Mr. Cavanaugh felt that the molder considered the mold maker always wrong and any problem connected with the mold would be primarily the mold maker's problem, even though it be outside his control, such as cure time, etc. Mr. Landall contributed to the discussion mainly from an advisory and consultive viewpoint.

Prior to the speaking program, the usual social hour and dinner were held with a short business meeting after dinner. Mr. Ed Childs, the Section Chairman, reported on the Section's activity in regard to the appointment of a new National Executive-Secretary.

Mr. W. Bentley, Program Chairman, has reported that the May meeting will consist of a Polyester Fiberglass symposium, and that the June meeting will be our Annual Western New England Golf Outing.

The regular meeting date of this Section is the first Wednesday of each month.

Chicago Topic Is Molding Filled Styrene

M. A. Self

The March meeting featured Mr. R. H. Bradt, President of Fiberfil Corporation of Warsaw, Indiana. His topic was "Injection Molding and Properties of Fiberglas Reinforced Polystyrene." A group of 133 members and guests were present for the dinner-meeting and participated in the question-answer period.

Mr. Carl Nagy, President of General Die Mold Company, passed away March 9. Mr. Nagy was only 46 at the time of his death. He had been an active member in the Chicago Chapter and will be missed by his many friends.

Officers and directors of the Chicago section for 1953 are:

President, John T. Bent, Eastman Chemical Products Inc.; Vice President, Ned H. Porte, Gen. Am. Trans, Corp.; Sec.-Treas., M. A. Self, Logo, Inc.; Natl. Dir., Lee J. Swift, Jarrow Products; Membership Comm. Chairman, Henry C. Carlson, Koppers Co.

Directors:

T. F. Muckenfuss, J. B. Products Co.; Harold Froberg, Colonial Kolonite; T. H. Cleavenger, Anesite Company; Frank L. Fine, Rohm & Haas Company; Kenneth Gossett, Gossett & Hill; Maurice Meltzer, Service Plastics (Pres. Emeritus).

Research Plans Interest Houston

W. E. Wiese

Plans for research in rubber and plastics at the Southwest Research Institute was Mr. MacPhee's subject at the March 18 meeting of the Houston Section. Mr. P. A. MacPhee is Plastics and Rubber Technologist with SRI, in San Antonio. SRI is a nationally recognized organization whose facilities are available to individuals and small companies at reasonable cost. Mr. MacPhee described the way in which SRI is organized to handle efficiently a broad variety of problems in almost any technical field. In the relatively short time in which they have been accepting problems in the fields of plastics and rubber they have found there is a definite need for this type of service in the Southwest. As quickly as time and financial resources permit they are equipping a laboratory with complete facilities for experimental work in these fields.

The program was preceded by a social hour and dinner.

CHICAGO BOARD MEMBERS

Chicago Board of Directors (left to right) Henry C. Carlson, M. A. Self, L. J. Swift, Ned Porte, Jack Bent, Maurice Meltzer, R. P. Smith, F. L. Fine, and Charles Schiff.

Extrusion and Drawing of Polystyrene Are Discussed at Philadelphia

Adolph Kissileff

Philly's March 24th meeting, again in conjunction with the local SPI Chapter was held as usual at Franklin Institute.

Earl R. Kropscott, Chief of the Dow Chemical Co.'s Plastics Technical Service, and his assistant, John M. Hoy, presented a program especially interesting to extruders and fabricators. Approximately 100 were on hand. The subject — "The Extrusion and Deep Drawing of Polystyrene."

Kropscott outlined details for setting up extrusion equipment to produce flat sheet stock, and with a series of diagramatic slides, pointed out the advantages of extruded sheets over cast materials. This was followed by a motion picture film in which deep drawing of Dow's high impact Styron 475 was illustrated. By the use of radiant heat and vacuum, it was shown how material can be heated in shorter cycles and the speed of the draw increased. Using this method, .060" sheets were heated to forming consistency in 60 seconds, and the entire cycle from heating to cooling required less than 2 minutes.

Mr. Hoy added to the interest of the program with more explanatory remarks on the equipment and its advantages over less modern machinery.

President Charley Davis of the Philly Section announced that the 1953 Golf Outing will take place Tuesday, June 16th at Cedarbrook Country Club, one of Philadelphia's finest. George Koch, Outing Committee Chairman, is preparing a program that promises to be as elaborate as any we have had so far, topped off with after-dinner entertainment usually classified by the show world press agents as super-colossal.

Dick Bishop has been designated to direct the activities of setting up the 1955 National Convention with Adolph Kissileff assisting him. Also announced was the appointment of Walter Fuller to serve for the unexpired term of Director Milton Stokes, whose increased business activities have forced him to resign this post.

The event of the year will take place some time in June (after the outing, we hope) when George Koch, erstwhile confirmed bachelor, takes as his bride the lovely Mary Marshall, whom the Philly members had the extreme pleasure of meeting at the Ladies Night meeting last December.

High Frequency Sealing is Topic At Ontario Section

R. H. Strong

The Ontario Section again held their popular panel discussion, and the experts on the panel were members of our own section.

Mr. T. Wold of Smith and Stone Ltd. was the expert on compression molding. The questions from the floor all dealt with means of eliminating and cutting to a minimum, flash on compression pieces.

Mr. T. McLellan of Duplate Canada Ltd. discussed rated capacities of extruders, in answer to a question from the floor on the possibilities of extruding right up to the limit of the rated capacity of the machine by making multiple orifices for every job.

The third member of the panel of experts was Mr. M. Spencer, Ray Plastics. The question asked him was also on rated capacities, and the questioner wanted to know if it was advisable to try in every case to mold right up to the rated capacity of an injection machine, and with what exceptions.

Future Developments in the Plastics Industry Discussed by Five Speakers at New York

A. M. Merrill

Five speakers participated in a symposium on "Things to Come — Future Developments in the Plastics Industry" at the March 18 dinner meeting of the New York Section. Held at the Gotham Hotel, the meeting attracted an attendance of approximately 100 members and guests who joined in the open discussion period that followed the talks. Program chairman Irvin I. Rubin, Robinson Plastics Corp., presided over the symposium, and the speakers were: Harold M. Day, supervisor of polyester development, American Cyanamid Co.; Wilfred G. Harvey, vice president and general manager, Guy P. Harvey & Son Corp.; E. V. Hellyar, assistant sales manager for thermoplastics, Monsanto Chemical Co.; Jules A. Jupa, technical engineer, M. W. Kellogg Co.; and Winslow A. Ward, III, supervisor of thermosetting molding compounds, American Cyanamid Co.

Speaking on the polyester resins, Mr. Day reviewed their history and development, and described their properties, methods of handling, and the fabricating of glass fiber reinforced products. Both military and civilian applications of the reinforced plastics were covered briefly, the speaker noting that some 125 different applications are used by the Armed Services. Newer developments in polyesters include resins that retain their strength at high temperatures; self-extinguishing resins; resins with good electrical properties at high temperatures; and resins that are non-yellowing upon exposure to sunlight. While the future outlook for polyesters is excellent, Mr. Day stated that further technical research will be aimed at lowering costs and accumulating the necessary stockpile of engineering data on the resins.

Mr. Harvey described his company's new Cylector, a completely automatic injection molding machine that is pneumatically operated. Made in a three-ounce capacity, the machine is designed for rapid, laborless operation with minimum maintenance. Employing a measured feed hopper, newly designed heating cylinder, and cartridge type heaters, the machine is said to produce parts at a molding pressure of 12,500 psi. that require a pressure of 20,000 psi. in other types of injection machines. Other features of the Cylector include three-tie rod construction for accessibility; 90-ton clamping pressure; molding area of 54 square inches; stainless steel cylinder components; plasticizing capacity of 60 pounds of acetate and 50 pounds of styrene per hour; two-pressure mold closing to avoid mold damage; automatic shut-off in case of trouble; and 3-6½ inch adjustable plunger stroke. Available accessories such as a discharge and sorting attachment, standard mold bases with built-in degaters, and knockout cylinders aid in reducing labor and handling costs. The machine is said to have a dry cycle of four seconds, and cycles ranging from 7-18 seconds in the actual molding of parts both with and without inserts. Savings of up to 80% in molding labor, and production increases of up to 30% per cavity are obtainable with the new machine, Mr. Harvey declared.

Mr. Hellyar spoke on future improvements which can be expected in thermoplastic materials, particularly styrene. The current trend in styrene is toward impact resistant types, but the future should see the development of such a resin that is comparable to general purpose styrene in transparency. The future should also bring the development of styrenes that are light stable, solvent resistant, flame resistant, boilable, destaticized, impact resistant at low temperatures, and show exceptional flow qualities in both copolymer and general purpose grades. While cost is an important factor, many of these developments can be expected in the near future, the speaker stated. As for other thermoplastics, Mr. Hellyar predicted the development of polyethylene with a non-waxy feel; oriented nylon in molded form; injection type vinyl compounds in a wide range of types; and improved forms of acrylic, cellulosic, fluoroethylene, epoxy, and silicone resins.

Mr. Jupa described the development, properties, and molding of KEL-F polytrifluorochloroethylene resins. Injection molding of KEL-F requires relatively high pressures, and the use of chromium plated or stainless contact metals to prevent contamination of the material. Extrusion requires the use of screw speeds in the range of 7-19 rpm., and dies 15-25% larger than the finished profile dimensions. Extruded KEL-F can be drawn and oriented to improve strength properties, but the problem of decomposition at very high temperatures is a serious consideration in extrusion. KEL-F can be compression and transfer molded, but the use of fully positive molds is desirable. Dispersions of KEL-F are used for coatings which are fused after being applied, and form a clear, continuous film. KEL-F oils and waxes are available for use as impregnants, and as plasticizers for the molding grades.

Speaking on amino types of thermosetting plastics, Mr. Ward noted that dimensional shrinkage presents the greatest problem with ureas. While great strides have been made in reducing shrinkage, further improvement is needed to approach the shrinkage properties of phenolics. Melamines find their greatest usage in tableware, and the major problem here is coffee staining. A great improvement in this respect can be looked for in the near future, the speaker declared. Recent improvements in amino resins include a transparent thermosetting molding compound that is relatively weak but provides heat resistance; glass-filled melamine with good electrical and dimensional properties that can be compression or transfer molded; and a urea compound for plunger molding. Future research on amino resins will be aimed at reducing shrinkage and improving dimensional stability.

Section president Saul Blitz, Noma Electric Corp., presided over the business session that preceded the symposium, and introduced some of the guests present. Special mention was made of the fact that the New York Section now has its first woman member, Miss Elizabeth Martin. Table favors were distributed through the courtesy of Ideal Toy & Novelty Corp., and the meeting closed with a drawing for door prizes contributed by Aurora Plastics Corp., and Naugatuck Chemical Division, United States Rubber Co.

Nine new members were added by the Section in March, as follows: Carl J. Birkmaier, Dow Chemical Co.; Bart Borras, Ideal Toy Corp.; Edwin Eisner, Einson-Freeman Co., Inc., Walter C. Haller, Rohm & Haas Co.; James J. Jacobson, Jacobson Associates; Robert R. Kobak, Westchester Plastics, Inc., Roger H. Motten, PM Industries, Inc.; Julius S. Spear, Sarco Co., Inc.; and Bud Ullman, Kuhn & Jacob Molding & Tool Co. As for potential membership, congratulations are due Mr. & Mrs. William Lewi (Universal Tool & Mold Co., and Section secretary-treasurer) over the birth of a son, Gary Leon, on January 3, and to Mr. & Mrs. Guy A. Martinelli (Silvan Plastics, Inc., and Section house committee chairman) for their new daughter, Joan, born on January 11.

Sam Silberkraus, Riverdale Plastics Development Corp. and an ex-president of the New York Section, recently returned from a trip to Haiti where he acted as consultant in the setting up of that country's first injection and compression molding plant.

South California Symposium On Reinforced Plastics

Austin Herbst

Approximately 125 members and guests heard a timely, first-hand report on the highlights of the "8th Annual Society of Plastics Industries Technical and Management Conference On Reinforced Plastics" held in Washington, D. C., on February 18-20, 1953.

Speakers included:

1. Mr. Milton Brucker, President, Zenith Plastics Company who reported on "Equipment, Presses and Molds." A film showing the manufacture of metallized molds at Zenith Plastics was presented. Molds up to 30" x 18" in size have been made and used for the molding of low pressure laminated parts.

2. Mr. W. Brandt Goldsworthy, President, Industrial Plastics Corporation who reported on "New Developments In Fibrous Reinforcements."

3. Dr. Palmer W. Griffith, American Cynamid Company who reported on "New Developments In the Field of Resins."

4. Mr. Paul Erskine, Owens Corning Fiberglas Corporation who reported on "The Government Agency Forum." The report included a list of the current applications for reinforced plastics and the respective department in the government who was sponsoring the work.

A large number of our members attended the recent Society of Plastics Industries reinforced plastics meeting held in Washington, D. C. Mr. Bruckner and Mr. Goldsworthy each served as a moderator at one of the technical sessions.

St. Louis Hears About Electric Motors

George A. Stein

The St. Louis Section meeting was held at the Melbourne Hotel on March 24, 1953. Forty-seven members and guests attended the meeting and heard two very proficient speakers.

First to speak was Mr. Otto Wulfert, Chief Mechanical Engineer of the Electrical Division of Wagner Electric Company. Mr. Wulfert, a member of the St. Louis Section, repeated and enlarged upon the paper he presented at the recent Boston SPE meeting entitled "Plastic Problems in Electric Motors."

His paper, and the discussion following its presentation, included the reasons for using plastic components in electric motors, listed many of the present uses and materials, and provided a thought provoking development of future possibilities and necessities in electric motor manufacturing.

The second speaker also presented a first-line topic which caused much discussion among those present.

The speaker, Mr. Kenneth E. Kichline, presented a talk and a sound picture entitled "Small Business and the Air Force." Mr. Kichline represents the St. Louis Air Regional Office, Mid-Central Air Procurement District, Air Materiel Command.

He discussed proper methods for doing business with the Air Force and related military organizations. Outlined proper operational procedure in obtaining Air Force prime — and sub-contracts, and invited and encouraged those present to make their facilities available for Air Force production.

He further stated that approximately sixty percent of the Air Force business is now being done by small business enterprises, and that more contractors are necessary.

The sound picture "Small Business and the Air Force" is a new 22-minute film by which the Air Force is trying to encourage small business participation in the Air Force program. It, and an explanatory pamphlet, are available through all local Air Materiel Command offices. Showings are encouraged prior to June 30, 1953.

S. E. Ohio Sees Film On Chromalox Heating

J. Chomicz

The Southeastern Ohio Section of the SPE met on March 19 at the newly opened Beverly Hills dining room located west of Cambridge, Ohio.

At the conclusion of the regular business meeting, Frank Bailey, a director of the section and chairman of the Membership Committee submitted his resignation. He is being transferred by the Continental Can Company from Cambridge to Milwaukee, Wisconsin. A new Membership Chairman will be appointed by President Verburg at the April meeting.

The entertainment portion of the meeting consisted of films and discussion on the Chromalox system of electric heat and methods of control as applied to the plastic industry. Mr. W. L. Thomson represented the Edwin L. Wiegand Company, manufacturers of the Chromalox heaters. He was assisted by SPE member Tom Musgrove of the Andrew Boles Corporation of Cleveland.

Attendance at this meeting consisted of 33 members and guests representing twelve companies in this area.

Detroit Mourns Andrew Kovacs

Emil R. Gazdick

The Detroit Section is grieved by the passing away of Andrew Kovacs, one of its members of long standing. Mr. Kovacs passed away on March 1st., after a short illness.

Andrew was associated with his brother George in the ownership and operation of the General Machine and Tool Company, of Walled Lake, Michigan. This company is one of the leaders in the development and operation of giant injection presses. At present they operate the only existing 300 ounce injection molding machine in Michigan.

Andrew is survived by his wife and four children.

It is with regret that the plastics industry records the passing away of one of its development pioneers.

Andrew Kovacs

On March 27th., the Detroit and Toledo Sections had the rare opportunity of meeting the officers and members of our National Council. A dinner meeting of the two sections was held at the Rackham Memorial Building which followed a meeting of the National Council.

Mr. Walter Oelman was our guest speaker. In his talk Walter gave our members a review of our Society growth and outlined plans for the future. This was truly one of the most successful meetings ever held in Detroit.

The April 20 meeting was followed by a round table discussion on the subject "Materials Handling." The moderator was Mr. George Demorest of Wayne University, Assistant to the Director of Materials Management Center, School of Business Administration, Wayne University, Detroit, Michigan. Other members of the panel were Mr. John G. Anderson materials Handling Consultant, Detroit, Michigan, and Mr. John Totten of the Ford Motor Company.

Advantages of Fully Automatic Molding Are Presented at Connecticut Meeting

David Mersey

The subject, 'Automatic Molding' was presented before forty members and guests by Mr. Quentin White, of F. J. Stokes Co. (compression), and Mr. Fred Means, Fellows Gear Shaper Co. (injection).

Both techniques have much in common. In automatic molding, one machine does the complete molding operation except for feeding the hopper and removing finished parts; thus differing from semi-automatic molding wherein the press removes the time-cycle from the operator's control. Further, in the automatic operation, labor is reduced to a minimum; one man can run a battery of presses. This type of press is not limited to single cavity molds; Mr. White had several specimens of parts which were run on 30 and 16 cavity molds.

The advent of new thermo-sets has wrought many changes in this field:

a. The entire field has been enlarged;
b. Fast cure materials have increased production.
c. Molding time has become more important, i.e., actual operating time has been shortened. In the new, small presses, used with alkyds, a greater percentage of the molding cycle is used in actual molding.

In the question period which followed, several points were made:

a. The presses can be run at a capacity of 95% efficiency; the other 5% going into maintainance.
b. Tool design favors semi-positive molds, with a combing device for removing finished parts.

Mr. Means pointed out, to have successful automatic, injection molding, two requisite are necessary:

a. Tool design;
b. Machine with good repeat accuracy.

Several slides showed the possible ways of handling the problem of gating, etc.:

a. Sprueless molding, which might be done with all thermoplastics except nylon;
b. Three plate dies;
c. Spring return knock out device.

Homar Plastics Co., a new compression plant is now operating in Waterbury; and, Auto-Vac Co. is now manufacturing vacuum forming equipment in Fairfield.

Ontario Panel Discusses Molding

R. H. Strong

Mr. H. G. Klawunn, of the Singer Sewing Machine Company, New York, N. Y., addressed the members and guests of the Society of Plastic Engineers, Toronto Section at their January dinner meeting, on the subject of High Frequency Sealing of Plastic Sheeting and Film.

Briefly sketching the history and background of the vinyl industry, he pointed out the need for electronic sealing, as a method of producing a less costly product with its advantages of speed, ease of control and a resultant uniform strong seam. Mr. Klawunn spent some time discussing the new product fields opened up to the processors through the accomplishments of the High Frequency Electronic Seamer. In the testing of seam strength he pointed out that his company set up a Seam Research Laboratory in which problems of all types of fabrication were worked out.

Mr. Klawunn's treatment of the types of high frequency equipment available was enjoyed thoroughly, and he spent some time answering the questions of the members and guests at the conclusion of his address.

Thermosets Topic At Rochester

Charles J. Williams

Mr. W. A. Ward delivered an interesting talk on "Urea and Melamine Thermosetting Molding Compounds."

The manufacture, molding, finishing and properties were covered in general. Little known characteristics and interesting facts about both types were treated in a specific manner. Plunger molding of urea and melamine compounds were discussed in relation to their application to existing molds where color is desired. Specialty materials and recent developments were outlined together with end use patterns.

Central Ohio Talk "Plastics Tooling"

A. P. Young

Mr. N. C. Taylor, Eastman Chemical Corporation, addressed the Central Ohio Section at their March meeting. The subject for the evening was "Plastics Tooling." About thirty members and guests were present.

Mr. Taylor preceded his talk by a showing of the color movie, "The Story of Tenite." The talk was built around four main points to consider in producing a new plastic part: (1) The design of the part; (2) The material from which the part is to be made; (3) Tool design for producing the part; and (4) Injection molding technique. Mr. Taylor is an excellent speaker and his talk was thoroughly enjoyed.

Plastic Bonded Abrasives Described At Buffalo Meeting

A. G. Scutt

The growing use of plastics in the manufacture of abrasive products was explored by Dr. Peter L. Shanta, senior engineer, Research and Development, The Carborundum Company, in a talk delivered before the Buffalo Chapter of the Society of Plastics Engineers.

In his presentation, entitled "Resin Bonded, Laminated and Reinforced Abrasive Products," Dr. Shanta noted that the speeds at which grinding and cut-off wheels are operated by industry are continually increasing.

"To insure safety at the higher speeds of operation, which are expected to improve performance," stated Dr. Shanta, "it is necessary to increase the strength characteristics of the abrasive products accordingly. To this end more emphasis is being placed on the use of plastics in making wheels and in the application of reinforcing agents in plastic-bonded wheels."

In reviewing the methods and constructions being utilized to attain the safety and strength requirements, he revealed that while chemical adhesion between abrasive grain and resin bond has played the most important role in the past, present trends are more in the direction of mechanical or physical reinforcement. The latter incorporates the use of woven and non-woven fabrics of glass, cotton, or nylon; glass or nylon cords; or flock of glass, synthetic or natural fibers.

Dr. Shanta also presented an interesting comparison between various industries using unfilled, powdered phenolic plastics, including the abrasive, shell molding (foundry) and brake-lining industries.

Dr. Shanta came to Carborundum in 1948 from the Case Institute of Technology, where he held a Glenn L. Martin Fellowship. He was graduated from the University of Pittsburgh in 1943 with a Bachelor of Science degree in Chemical Engineering and two years later obtained his Master's degree there. He later obtained a Ph.D in Chemical Engineering at the Case Institute of Technology.

Closed Mold Molding

(continued from page 16)

a gate size of ¼" x ⅝". Without a doubt, this would be a difficult part to mold by the compression molding method. Compression molded test specimens of the material used on this part show an impact of 5.4 ft. lbs. A cut-out section from the finished plunger molded part has an impact of 2.7 ft. lbs. This means a reduction of 50% in impact strength.

Most interesting results of filler orientation between compression and the closed mold method are in the glass-filled phenolic material (Figure 15). For the plunger molded specimens, a gate of .070" deep and 7/16" wide was used. These results are quite clear and should not require any comment except that the closed mold methods are not recommended for this type of material. Sprue-type molded slabs and test specimens machined were somewhat superior; 5/16" diameter x 1½" long sprue resulted in a 3.0 ft. lbs./in. impact.

Most of the difficulties in this method of molding are caused by the destruction of the filler and compressibility of the material. Generally when the part is almost filled and the material within this part is semi-set, there is still some live material being forced in. This creates a ball joint of fresh material within the semi-set material resulting in a definite weld joint. A molded part of this type will crack upon cooling or is very weak.

In conclusion I make this very broad statement. All these problems can be minimized or eliminated by the use of proper gating, preheating, molding pressure, amount of material, and cutting off the plunger pressure at the precise time the part is filled out.

Egan Co. Appoints Willert

W. H. Willert, formerly sales manager for the Hartig Engine & Machine Company, has been appointed to the technical staff of F. W. Egan & Company of Bound Brook, N. J. He will handle the development of plastics extruding and processing equipment.

W. H. Willert

Graduating from Michigan State College in 1942 with a chemical engineering degree, Mr. Willert has specialized in the design and development of plastics extrusion equipment and extruded products. He is active in the Newark Section of the Society of Plastics Engineers and holds a Professional Engineer's license in the state of New Jersey.

Previous to this new undertaking, Egan furnished the plastics and paper industry with film and web handling equipment. With their expansion into the design and manufacture of extruders and dies, the equipment is being extended in accordance with the Company's policy of offering completely engineered and modern installations for other plastic products as insulated wire, film and sheeting, pipe, monfilaments, coloring and compounding, rods and other extruded items.

CLASSIFIED ADS

Positions Open

PLASTICS ENGINEER

Diversification of extruded Thermoplastic products line by well-established company located New Jersey metropolitan area creates excellent opportunity for man having some experience with rigid vinyls. Primary responsibility will be research and development. Please submit complete resume for prompt and confidential consideration to box #1453, SPE Journal, 513 Security Bank Bldg., Athens, Ohio.

TECHNICIANS NEEDED: Two to five years experience in materials or plastics laboratory. Will work under supervision of chemist or chemical engineer in processing or application of plastic materials, the etching and plating materials, will also test materials used in the fabrication of electronic equipment. Write for employment application box 1758, SPE Journal, 513 Security Bank Bldg., Athens, Ohio.

Classified Ad rates: fifty cents per line, each insertion. Ads of SPE members seeking positions are run free of charge.

Positions Wanted

EXTRUSION: Thorough knowledge of vinyl powder blending, coloring and extrusion for profile sections, pipe and film. Estimating, production, development, sales and administration. Previous background of compression, injection and low pressure molding. Fifteen years experience in the plastics industry in engineering and administration. Desire position in administrative or technical sales service. Reply Box 1653 S.P.E. Journal, 513 Security Bank Bldg., Athens, Ohio.

PLASTICS ENGINEER with 12 years experience in research and development, desires to relocate. Write to box 1853, SPE Journal, 513 Security Bank Bldg., Athens, Ohio.

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FOR SALE—VERY CHEAP—5 INJECTION MOLDS PLUS A GOOD QUANTITY OF COMPONENTS. MOLDS ARE FOR A 5" ROUND COMPACT—A FLAT CIGARETTE CASE—A SQUARE CIGARETTE BOX —A PIANO CIGARETTE BOX AND A 16 CAVITY MOLD FOR MIDGET WIND-UP CARS. PRICES AND ADDITIONAL INFORMATION UPON REQUEST. Box 269, Dept. W, Erie, Pa.

Factors in Transfer Molding

(Continued from Page 19)

the molding behavior, including transfer flow, of phenolics. This is particularly notable in any comparison of woodflour and asbestos-filled materials. Preheating is more rapid and flow period shorter with asbestos-filled formulations, other factors being equal. While we cannot prove our thesis beyond question, we believe this effect is due to the greater heat conductivity of the asbestos-filled material, which hastens polymerization. Whatever the mechanism, it is an experimental fact that the behavior of asbestos filled materials in transfer molds is more critical than that of cellulose-filled compounds.

Mica-filled materials behave differently and pose peculiar problems of their own. Although mineral-filled, they are less reactive than cellulose-filled general purpose materials. This is due to the special, modified resins used in them to enhance electrical properties. Because of this fact, and because the filler is non-absorbent, these compounds are more fluid and tend to flash more in plunger molds than cellulose-filled materials.

Since the mica filler is less readily wetted by the resin, these materials are also more prone to stick in molds. In transfer molds, this tendency is frequently greater in the runners than in the cavities, possibly because pressure is greater at these points and the runners may not be as well polished as the cavities.

Please do not assume from the foregoing that mica-filled materials are always and inevitably difficult to mold. This is not the case. While the difficulties mentioned above are still encountered occasionally, the general molding performance, and particularly the transfer behavior of these compounds, have been vastly improved in recent years.

Volatile Content

Varying amounts of volatile matter, principally ammonia, formaldehyde and water vapor, are evolved from phenolic materials during cure in the mold. These are by-products of condensation and polymerization. Most of this escapes from the mold in one way or another; some is occluded within the hardened mass of the molded part.

In addition, some moisture, usually not more than 2 percent, and derived principally from the woodflour, is present in the phenolic material as received ready for use. This is not altogether an unwanted nuisance—some of it is actually desirable to insure good plastic flow and satisfactory cohesion in preforming.

Since, however, this volatile matter has no known beneficial effect in the finished part and actually impairs electrical properties seriously in some applications, its effective removal during molding become quite important. Hence, the recommendation made earlier concerning venting of transfer molds. Unless these escape channels are provided it is extremely difficult, if not impossible to remove this volatile matter. If it is not removed during molding, a number of unpleasant developments can occur —longer cure, blistering, short pieces and staining, to name but a few.

This is particularly evident with mica-filled material, probably because the filler is non-absorbent and will not pick up and hold permanently any of the volatile matter produced. Even where these more obvious symptoms do not occur, mica-filled material, which is inherently brittle, tends to develop strains during molding and the molded parts may crack around inserts or between closely adjacent holes. This tendency is apparently aggravated by the presence of any excess volatile matter in the molded parts.

In a number of cases I have found that preheating the material before molding in a circulating air oven at temperatures of 180 to 240°F. will overcome this difficulty and is preferable to dielectric preheating for this purpose. The optimum preheat temperature and time must be determined by experiment and should be the maximum possible without advancing the cure and stiffening the plasticity of the material. A period of one-half to one hour is suggested as a starting point in any tests of this nature, particularly with soft plasticity material. Obviously, the preheat time will be shorter at the higher temperature.

This completes my catalogue of the properties of phenolic material which we consider important in transfer molding. No doubt other factors will be found and additional information obtained as further development work continues. This work is going on steadily toward the goal of increased productivity from your transfer molds.

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Preheating of Preforms

(Continued from Page 9)

keep the top of the lamps underneath the screen clean since dust dropping from the preforms onto the surface of the lamps will substantially retard their efficiency.

Many of you are very familiar with much of the information presented here. However, if even one or two new angles on the technique of preheating thermosetting materials for transfer or plunger molding have been presented, this paper has accomplished its purpose for the mutual benefit of The Society of Plastic Engineers.